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CONTENTS

The Hatchability of Eggs from Hens Fed Rations Containing Different Protein Supplements
S. Fox and R. S. Martin 4

A Comparison of Pullets Housed Singly and in Pairs in Laying Cages
R. T. Morris and R. C. Jennings 6

Enzymes in Feeds for Poultry
J. C. Fritz 19

Reassessment of Vitamin Requirements for Poultry
R. T. Parkhurst 20

Amino Acid Requirements of Poultry
H. J. Almquist 22

From Barren Waste to Thriving Industry
Robert S. James 30

Selection for Egg Production
Fred Skaller 36

Fertility, Hatchability and Egg Production of Poultry at University College, Ibadan
A. N. A. Modebe and D. H. Hill 47

Important International Award 55

The Canadian Poultry Breeding and Hatchery Industry
A. S. Johnson 56

Australian Branch Subscription (A Correction) 62

In Memoriam 63

Review of Poultry Publications 64

World's Poultry Science Association
Patrons of the Association 88

Affiliated Organizations 88

New Members 92

Address Changes 96

THE HATCHABILITY OF EGGS FROM HENS FED RATIONS CONTAINING DIFFERENT PROTEIN SUPPLEMENTS

S. FOX and MISS ROSALIE S. MARTIN
University of Reading, England

Experiments at Reading have shown a consistent fall in the hatchability of eggs laid by hens whose diet has been supplemented with 10% white fishmeal (Black et al, 1953). This has been shown to occur whether the breeders' basic ration is a simple mixture of cereals, or whether it is more complex with additional sources of protein and vitamins. It has, therefore, become pertinent to know if the commonly recommended content of fishmeal in a breeders' ration should be substantially reduced or replaced. Further it is necessary to know what other protein sources should be used to maintain high levels of egg production.

If we take the second issue—that of the replacement of the fishmeal by some other protein source, then the following questions are relevant:—

Is the depression in hatchability

(a) specific to fishmeal
(b) specific to animal proteins
(c) common to all protein supplements, when fed at a level of approximately 10% (by weight) of the ration?

OBJECT AND METHODS

In an attempt to answer these questions, an experiment has been carried out to test the four following rations:—

(1) Simple cereal mixture (known to give good hatchability).
(2) Cereal mixture plus fishmeal.
(3) Cereal mixture plus meat-and-bone meal.
(4) Cereal mixture plus earthnut meal.

The rations were formulated according to the schedule in Table 1. It will be seen that they are identical in composition except for the additional protein source and slight adjustments to balance the minerals. The three supplemented rations were calculated to contain the same percentage of crude protein.

These rations were fed to twelve pens of birds, allowing three replications of the four treatments. The birds were

TABLE I

Formulation of Experimental Rations

Name	Ingredients	Weight lb.	Crude Protein lb. %		Ca. lb. %		P_2O_5 lb. %	
1. R.O. (cereal base)	Maize	25						
	Oats	20						
	Wheat	20						
	Middlings	25						
	Bran	10						
	Salt	0.5						
		100.5	11.66	11.6	0.10	0.10	0.53	0.53
2. R.F.	Cereal base	100.5	11.66		0.10		0.53	
	Fishmeal	12.5	7.94		0.80		0.45	
		113.0	19.6	17.3	0.90	0.80	0.98	0.87
3. R.M.	Cereal base	100.5	11.66		0.10		0.53	
	Meat-and-bone meal	18.5	8.90		1.97		0.92	
		119.0	20.56	17.3	2.07	1.74	1.45	1.22
4. R.E.	Cereal base	100.5	11.66		0.10		0.53	
	Earthnut meal	18.5	9.47		0.02		0.12	
	Bone meal	3.0			0.98		0.41	
		122.0	21.13	17.3	1.10	0.90	1.06	0.87

TABLE II

Summary of Information

Diet	% Egg Production (Hen/Week)	Egg Set	% Fertility	% Hatchability (Fertile)	% Hatch All eggs
RO	58.5	2788	83.9	83.5	70.1
RF	55.5	2509	87.6	75.5	66.2
RM	58.5	2792	83.5	81.1	68.8
RE	58.7	2820	88.4	82.4	71.7

Light Sussex pullets running in groups of 30-35, in grass pens, and mated to Rhode Island cocks. Two weeks eggs were collected and set before differential feeding treatments were introduced. One week was allowed for the change onto experimental diets, and thereafter, thirteen weekly settings of eggs were made, according to their pen of origin. Hatchability of fertile eggs—which is used as the measure of comparison—was calculated by deducting clears at candling and dead-in-shell from total numbers set.

A COMPARISON OF PULLETS HOUSED SINGLY AND IN PAIRS IN LAYING CAGES

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Several million battery cages have been installed on farms in Great Britain during the past twelve years. Most of these cages are 14-15 inches wide and were designed to accommodate individual pullets. Following the "discovery" that two birds could be kept in each 15 in. cage, "twin-bird" cages (18 in. wide) and 10 in. wide "single" cages are now commonly offered as alternatives.

Since many farmers already possess 15 in. cages and the cheapest arrangement for new units is to buy 15 in. cages and install two birds per cage, it is important to know to what extent egg yield may be affected by "doubling up" in these standard-sized cages.

For several years past many poultrymen have made a practice of housing two birds in every cage, but there appear to be no published accounts of the relative performance to be expected from birds housed singly and in pairs. This report describes two such comparisons made in 14-14½ inch wide cages.

EXPERIMENT I

METHODS AND MATERIALS

This experiment was carried out in a battery of 1,408 cages of a standard commercial design. Each cage was 14½ in. wide, 17 in. high at the front and 16 in. deep, with sheet metal partitions between the cages. Individual food troughs were provided for each cage and water was supplied by a continuous gutter-type drinker.

The birds used were 2,488 Rhode Island Red x Light Sussex pullets which were the progeny of specific Light Sussex dams. These crossbreds had been pedigree wing-banded so that information about their performance could be used in the selection of their pure-bred parents.

Three groups of pullets were hatched from the same parent stock (for dates and numbers, see Table 1.) Hatch 1 was reared in tier brooders to 8 weeks and then in folds on grass to 20 weeks. Hatch 2 was reared intensively on litter to 17 weeks. This group was split so that half the birds (controls) received natural daylight only, whilst the other half

had an artificial light pattern designed to delay sexual maturity (Morris and Fox, 1958). Hatch 3 was brooded on wire

TABLE 1

Egg production and mortality to 45 weeks of age: Rhode Island Red x Light Sussex in hand-fed cages.

Hatch	Hatch date	No. of pullet housed		Eggs per pullet housed		Mortality, per cent	
		Singles	Doubles	Singles	Doubles	Singles	Doubles
1	13 Nov 57	94	1,018	110.8	98.3	2	6
	(Controls)	60	226	113.0	88.2	0	5
2	4 Dec. 57						
	(Lighted)	60	230	95.7	96.1	2	4
3	18 Dec. 57	110	690	108.5	102.1	5	4
Totals and weighted means		324	2,164	107.6	98.2	2.5	5.2

to 8 weeks and then reared in slatted floor turkey verandahs to 18 weeks of age.

The birds in each hatch were housed as sister groups with odd members of a family occupying a single cage. For example, a family of five made up two pairs and a single. The selection of birds to be housed singly was made at random within the odd-numbered families. In hatches 1 and 3 singles and doubles were intermingled in the battery. Hatch 2 was housed as four blocks of singles alternating with four blocks of doubles.

The three hatches were housed at 20, 17 and 18 weeks of age respectively and, once in the cages, all birds were treated uniformly. A standard laying mash (approx. 16½% crude protein; 900 Cals/lb productive energy) was fed *ad libitum* and management was similar to that in commercial battery plants, except that no birds were culled.

RESULTS

Egg production was recorded to 45 weeks of age for each group and the average yields are given in Table 1, together with details of bird numbers and mortality. The pullets housed in pairs laid about 9% fewer eggs per bird than those housed singly. This difference was spread uniformly throughout the laying period and the records for Hatch 2, which were kept up to 65 weeks of age, show that differences at the end of the laying year are of a similar order. An analysis of variance (method of weighted squares of means) shows that the odds are more than 5:1 against this 9% difference being due to chance.

Although the average mortality was higher amongst doubles than amongst singles it is an open question whether this difference should be attributed to the method of housing.

No records of food consumption were kept in this experiment, but body weight and egg weight data are available for Hatch 2. Egg grading was not affected by the method of housing and the differences in body weight were slight. At 40 weeks of age the average weight of singles in Hatch 2 was 6 lbs. 11 ozs. and of doubles, 6 lbs. 10 ozs.

EXPERIMENT II

METHODS AND MATERIALS

Some further evidence was obtained from a trial in which birds of four breeds were hatched and reared together and

housed in a cafeteria battery at 20 weeks of age. The cages were 14 in. wide, 17 in. high at the front and 17 in. deep and were constructed of woven wire with mesh partitions. Food and water were supplied by three "trollies" which were driven round the block of 252 cages on an overhead rail. Two thirds of the cages were filled with single birds and one third with pairs, the stock being allocated to treatments at random. The eight groups of pullets were arranged in the battery so that blocks of singles alternated with blocks of doubles.

The food used in this battery was a "high energy" pellet (approx. 18% crude protein; 1,010 Cals/lb. productive energy). Other birds of the same age, breeds and history were housed two per cage in a hand-fed battery in the same building. These were given the same food and management as the singles and doubles in the cafeteria.

RESULTS

Table 2 shows that egg production was lower for the singles with cafeteria feeding than for the doubles in the hand-fed cages. A further reduction in yield of about 19% was caused by doubling up in the cafeteria battery.

Mortality was considerably greater amongst the doubles than amongst the singles and this will have contributed to the reduction in hen housed yield in the cafeteria, though it cannot account for it altogether. Some cannibalism occurred amongst the Hybrid '505' doubles and this was partly responsible for their high mortality rate. But with the other three breeds, cannibalism was not a problem and deaths were due to the usual run of complaints—lymphomatosis, egg peritonitis and other non-specific disorders.

DISCUSSION

In these experiments egg production per bird was lowered by housing two pullets in a cage. This does not necessarily mean that birds will always lay fewer eggs when they are paired off. Many successful poultry keepers insist that their birds lay as well when housed two per cage as they would singly (though they are rarely able to offer any reliable evidence in support of this opinion). Others have tried doubling up and abandoned it as unsatisfactory—usually because of trouble with cannibalism.

Several different theories could be offered to explain the loss in yield caused by doubling up, but it would be dif-

ficult to arrange experiments to test these. Perhaps the simplest idea is that pairs of birds in very close confinement

TABLE 2

Egg production and mortality to 45 weeks of age; four breeds in cafeteria cages.

	No. of pullets housed			Eggs per pullet housed			Mortality, per cent		
Battery	Hand-fed	Cafeteria		Hand-fed	Cafeteria		Hand-fed	Cafeteria	
Breed	Doubles	Singles	Doubles	Doubles	Singles	Doubles	Doubles	Singles	Doubles
Light Sussex	120	60	60	83.8	83.4	70.9	12	3	12
RIR x LS	36	36	36	91.1	83.4	68.1	8	3	14
Hybrid 404	48	36	36	101.5	88.1	68.8	8	6	22
Hybrid 505	48	36	36	114.3	89.0	71.1	4	3	25
Totals	252	168	168						
Weighted means				94.0	85.6	69.9	9	4	17

are "competing" with each other, in the most general sense of the term, and that neither is able to give of her best under these conditions. Another possibility is that, where two birds with very different positions in the "peck order" are paired off, the socially inferior pullet is persistently bullied so that her yield is depressed. (This might be detected by an increase in the variance of cage records above the expectation of twice the variance of cage records for singles, provided that the pairs are drawn at random: in Experiments 1 pairs were sisters and therefore not randomly drawn: in Experiment 2 no cage records were kept.) In Experiment 2, where a cafeteria battery was used, competition for food may well have accounted for the lower yield and higher mortality of the doubles.

One obvious suggestion for reducing the effects of competition between birds is to give them more room and feeding space and this has led to the use of 18 in. wide cages. However, it is by no means certain that this improves matters; some poultrymen even suggest that the larger cages lead to more trouble because the birds find it easier to get at each other.

Clearly the optimum size of cage to be used for one, two or more birds needs investigation. There is no evidence that a cage 15″ x 18″ x 18″ is the most suitable for a single bird and, with body size ranging from about 4 to 8 lbs. it seems unlikely that any one type of cage will be the best for all stocks. This is illustrated by the fact that some farmers are now keeping three birds in a 15 in. cage which was once thought to be too small for a single pullet.

Leaving aside the major difficulty that we have no information on which to base the design of battery cages, four important questions remain to be answered in relation to the standard 15 in. cage. Firstly, is it generally true that egg production per bird is reduced by doubling up? Secondly, if it is true, then how much must one expect to lose in yield? Thirdly, is it true that in some circumstances birds can be doubled up without it affecting their performance at all? Fourthly, what factors affect the extent to which yield is depressed by doubling up?

The last point is particularly important since, if we understand the causes of lowered egg production, we may be able to modify the design of cage, the type of stock, the method

of feeding or management or the method of pairing off birds so as to get the maximum potential yield from pullets even

TABLE 3

Increase in profit per cage obtained by "doubling up".

Food cost per bird per annum			28/-			34/-	
Reduction in yield per bird caused by "doubling up"		0	10%	20%	0	10%	20%
Bird depreciation (cost of p.o.l. pullet minus carcase value)	Egg income per bird per annum (when housed singly).	Increase (or decrease) in net income per cage resulting from "doubling up" : shillings per cage per annum					
6/-	80/-	43/-	28/5	13/10	37/-	22/8	8/5
	65/-	28/-	16/5	4/10	22/-	10/8	-0/7
	50/-	13/-	4/5	-4/2	7/-	-1/4	-9/7
12/-	80/-	37/-	22/5	7/10	31/-	16/8	2/5
	65/-	22/-	10/5	-1/2	16/-	4/8	-6/7
	50/-	7/-	-1/7	-10/2	1/-	-7/4	-15/7

when they are housed as pairs.

Although yield per bird may be reduced by doubling up, this does not automatically reduce profits. To show how these two things are related we shall consider first the situation where a farmer wishes to get the maximum return from his fixed capital (i.e., profit per cage) and secondly the situation where he wishes to get maximum income per man.

PROFIT PER CAGE

Table 3 shows, for various cost structures, the increase in profit per cage which it is possible to obtain by doubling the number of birds housed. (It should be noted that this calls for a substantial increase in working capital). The method of calculating these figures is given in appendix A. A number of assumptions have been made, the most important of which are that the labour cost per cage is increased by 3/- per annum as a result of doubling up and that the depreciation and overhead charges per cage are not affected. These assumptions may not be strictly accurate but the figures given would be affected only slightly by adjustment of these quantities.

Table 3 shows that the potential advantage of doubling up is much greater where profit margins are already high and that a substantial improvement in income per cage can often be made by doubling up, even if yield per bird is reduced by 10%. If yield falls by as much as 20% then it is unlikely that return per cage will be much improved by using two birds; it may be drastically reduced.

It is important to notice that where a battery unit is making only a small margin of profit, doubling the number of birds is unlikely to improve the situation. For example, with an egg income of 50/- per bird, a food cost of 28/-, bird depreciation at 12/- and other costs amounting to 8/- per cage the profit per cage is 2/- (singles); if the number of birds in this unit is then doubled, with a consequent fall in egg production per bird of 10%, the total profit drops to 5d. per cage.

Table 5 shows, for two types of bird, the relationship between increased profit and the reduction in yield which may be caused by doubling up. (Food cost has been taken as £32 per ton and the extra labour needed for doubles as 3/- per cage per annum). This shows the importance of trying to

find ways of keeping two birds per cage without suffering any loss in egg yield.

Table 4 sets out the reduction in yield which will just offset the advantage of doubling up with various cost structures. This again shows that a much greater loss in egg production can be tolerated with a highly profitable bird than when margins per bird are low.

INCOME PER MAN

Self-employed poultrymen are likely to be concerned with their total income, rather than profit per cage. This applies particularly in considering the merits of a twin-bird unit since it involves a lower capital outlay than a single-bird battery having the same labour requirements.

The main factor to be considered is the number of extra birds which one man can look after when they are housed two per cage. This will vary considerably with the type of battery and the range of jobs which are included in the labour requirement. In most cases it seems that the increase in number of birds per man is between 33% and 66% (e.g., from 1,500 cages with singles to 1,000 or 1,250 cages with pairs).

Table 5 shows the percentage increase in income per man, for various cost structures, where the number of birds kept is increased by one-third by doubling up. Table 6 gives the same information for a two-thirds increase in birds per man. The method of calculating these figures is given in Appendix B; the only important assumption which has been made is that overheads and capital depreciation amount to 8/- per cage per annum. (For other capital costs the increase in income may be calculated from the formula given in Appendix B).

An important feature of Tables 5 and 6 is that they refer to total income per man. Labour costs have not been deducted so that the incomes shown are partly wages, partly a reward for management and partly interest on capital. The very high percentage increases in Tables 5 and 6 do not represent large absolute increase in income since they occur where the income per bird from singles is relatively small.

It is clear that income per man can scarcely be increased if doubling up results in a 20% loss in yield per bird. If yield falls by 10% then, whatever the cost structure, income per man increases by about 20% if one third more birds are kept

or about 50% if two thirds more birds are kept.

Finally, it should be observed that, if a battery unit is

TABLE 4

Values for the reduction in yield per bird resulting from "doubling up" which just cancel out the potential advantages of housing two birds per cage.

Food costs per bird per annum		28/–	34/–
Bird depreciation (cost of p.o.l. pullet minus carcase value)	Egg income per bird per annum (when housed singly)	When "doubling up" causes the reduction in yield shown below, net income per cage is no better with pairs than with singles.	
6/–	80/–	29%	26%
	65/–	24%	19%
	50/–	15%	8%
12–/	80/–	25%	22%
	65/–	19%	14%
	50/–	8%	1%

TABLE 5

Increase in income per man obtained by "doubling up" if the number of birds kept per man is increased by one third.

Food cost per bird per annum		28/-			34/-		
Reduction in yield per bird caused by "doubling up"		0	10%	20%	0	10%	20%
Bird depreciation (cost of p.o.l. pullet minus carcase value)	Egg income per bird per annum (when housed singly)	Percentage increase (or decrease) in income per man resulting from doubling up: (extra birds per man = 33-1/3%)					
6/-	80/-	47	22	- 4	50	20	- 10
	65/-	57	23	- 11	65	20	- 24
	50/-	100	28	- 43	300	23	-253
12/-	80/-	50	20	- 11	54	17	- 20
	65/-	65	19	- 26	82	13	- 55
	50/-	300	13	-273		(all loss)	

TABLE 6

Increase in income per man obtained by "doubling up" if the number of birds kept per man is increased by two thirds

Food cost per bird per annum		28/-			34/-		
Reduction in yield per bird caused by "doubling up"		0	10%	20%	0	10%	20%
Bird depreciation (cost of p.o.l. pullet minus carcase value)	Egg income per bird per annum (when housed singly)	Percentage increase (or decrease) in income per man resulting from doubling up: (extra birds per man = 66-2/3%)					
6/-	80/-	84	52	20	88	50	13
	65/-	96	54	12	106	51	- 5
	50/-	150	60	- 29	400	54	-292
12/-	80/-	88	50	12	92	47	1
	65/-	106	49	- 8	127	42	- 44
	50/-	400	42	-316		(all loss)	

already losing money, then the result of doubling the number of birds housed is, with very few exceptions, an increase in the loss—whether it is worked out per cage, per man or per bird.

SUMMARY

1. Two experiments, involving a total of over 3,000 laying birds are described. These compared the egg production of pullets housed singly and in pairs in standard 15 in. battery cages.

2. In these trials egg production per bird was reduced by 9% in hand-fed cages and by 19% in cafeteria-fed cages when the birds were housed two per cage.

3. Mortality was greater amongst the birds housed as pairs. The difference was significant in the cafeteria battery but not in the hand-fed cages.

4. Details of the extra profit which can be obtained are tabulated for various cost structures.

5. Despite a lowered yield per bird, the profit per cage would be higher in most cases as a result of doubling up.

6. The advantage of doubling up is greatest on farms where the profit margin per bird is already high. The reduction in yield per bird which can be tolerated without losing all the advantage of doubling up is also greatest where the profit margin from singles is high.

7. Details of the increase in income which can be obtained are tabulated for various cost structures.

8. If yield per bird falls by 10% as a result of doubling up, then income per man increases by 20% if one third more birds are kept, or by 50% if two thirds more birds are kept.

9. If a battery unit is operating with a net profit of only a few shillings per cage, then doubling up is likely to cause a reduction in profit.

10. If a battery unit is operating at a loss, then doubling up will almost invariably increase the loss.

REFERENCE

Morris, T. R. and S. Fox (1958). Nature, *182*, 1522.

ENZYMES IN FEEDS FOR POULTRY

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During the past year, there has been considerable interest expressed in feed use of enzymes. The enzymes are complex materials, usually protein in nature, which are responsible for most of the chemical reactions which take place in the body. Feed ingredients are useful only after they are broken down into their component parts which the body can use to form tissue or commercial products such as milk and eggs. Much of this is accomplished by the digestive enzymes.

From a theoretical standpoint, it is obvious that any increase in the quantity of useful enzymes should produce desirable changes in rate or efficiency of digestion and utilization of feedstuffs. Many workers feel that outstanding advances in this area can be expected within the next few years (Bird). It is one of these areas where there are obvious opportunities for increasing application of nutritional knowledge.

Progress, however, is slow. Many of the reports which have appeared during the past year elaborate on what was previously suggested. In a few instances, they have substantially extended applications of previously established facts. Much of the data presented at various nutrition conferences has not been published. An excellent review of the subject has been prepared by Jensen.

Further work has confirmed the effectiveness of amylolytic enzymes for the chick starting ration (Leong, *et al;* Dobson and Anderson; Wharton, *et al.*) The effectiveness for turkey poults has been well established (Fry, *et. al*). Most of these reports of favorable response to amylolytic enzymes were based on high barley diets and on barley grown in the Pacific Northwest area. Results on barley grown elsewhere have shown erratic results and sometimes no response to addition of amylolytic enzymes or to water soaking the grain (Hamm; Gerry). Jensen has reported more uniform response to water soaking.

Conflicting results have been reported on the value of enzyme additions to the laying ration (Berg and Bearse; Nelson and Hutton; Anderson and Wagstaff).

Other types of enzymes have received some attention. Pensac, *et. al*, observed that the proteolytic enzymes showed value as feed additives when protein was the first limiting nutrient in the diet.

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REASSESSMENT OF VITAMIN REQUIREMENTS OF POULTRY

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VITAMIN B_6

Hogan et al. (1941) estimated the vitamin B_6 requirement of chicks to be between 300 and 500 mcg. per 100 grams of feed. Briggs et al. (1942) placed it at 275-300 mcg. of pyridoxine per 100 grams of feed. Fuller and Kiefer (1959) obtained maxium growth and feed efficiency with 1.5 mg./lb. pyridoxine with a purified diet. This agrees quite closely with

the findings of Hogan et al. (1941) and Briggs et al. (1942). The addition of 2 mg./lb. pyridoxine to a simplified corn-soy ration containing 2.6 mg. vitamin B_6 per pound gave better feed efficiency but did not improve the growth rate. They suggest the need for further research with breeder rations.

Davis et al. (1958) reported depressed egg production when 6 grams per ton of pyridoxine was added to a layer cage ration containing 3% calcium, 15% protein and 800 cal./lb. It had no effect when the ration contained 2.25% calcium, 18% protein and 1000 cal./lb. of ration.

VITAMIN A

Bearse and Berg (1958) report results which indicate that, with high energy in particular, the N.R.C. requirement for vitamin A may be marginal for the production of eggs with the lowest possible blood spot incidence, further research is needed.

VITAMIN D (PHEASANTS)

Scott el al. (1958) reported the minimum vitamin D requirements of pheasants housed in darkened pens on litter to be between 480 and 680 I.C.U. of vitamin D_3 per pound of ration. The requirements are influenced by levels and ratios of calcium and phosphorus, amount of phytin phosphorus, and the source, and especially the stability, of the vitamin D.

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AMINO ACID REQUIREMENTS OF POULTRY

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Papers having a bearing on quantitative requirements only have been considered. Many other papers on amino acids have appeared, which do not represent work that was conducted from the requirements viewpoint, i.e. by the use of more than one level of the amino acid in question. In some cases, papers having a bearing on certain phases of the requirement have been included. Unless of special interest, abstracts, are not reviewed.

In studying some of these recent reports in detail the writer must confess he finds it hard to make sense out of the interpretations or to arrive at as finely drawn conclusions as have the authors. For example, considering amino acid requirement data in terms of caloric content of the diet is, unfortunately, highly confusing to all but those who have opportunity to study the work closely.

Let us make it clear that there is no basic relation between amino acid requirements and caloric intakes. A close relation does exist between amino acid requirements and the levels of suitable quality of dietary protein. It is the efficiency of use of the latter as protein to make new tissue and new animal products that is related to caloric intake. This situation causes an *apparent* relation between amino acid requirements and caloric intake.

The energy content of the diet has several dominant effects.

1. Limiting of voluntary feed intake to the caloric needs of the animal. In this way limiting intake of other nutrients including protein.
2. Sparing of protein that would have been burned in meeting the caloric need.
3. Specific effects such as the increased choline requirement in high fat diets, which could cause a diversion of methionine for the syntheses of extra needed choline.

CHICK

Arginine. Numerous reports have shown that excessive levels of arginine appear to be required in a simplified casein type diet. Using such a diet supplemented with glycine and

methionine it was found that about 21% protein gave maximal 3-weeks chicks weights with 1.23% total arginine. Corn and soybean oil meal appeared to contain a factor which reduced the arginine requirement of chicks (1).

Male Leghorn chicks were prepared by operation so as to allow separate collection of urine and feces. Analyses of urine for arginine, urea and creatine were made the basis for estimating the utilization of arginine. The apparent digestibility of arginine from casein, liver protein, gelatin, corn-soybean diet, and casein-arginine diet varied over a narrow range from 95 to 98 percent. Apparently, differences in digestion and absorption would not account for the marked differences in arginine requirement of chicks, as reported with various diets. It was postulated that the higher requirement for arginine found with an arginine-supplemented casein diet might be due to more rapid absorption and loss of the free amino acid (2).

From results with a simplified diet, containing only amino acids as a source of "protein" it has been reported that good chick growth was obtained and that the optimal level of arginine was 1.16% which compares closely with the N. R. C. recommended level of 1.20%. Details of the results were not given. The equivalent protein level was 30%, which makes comparison with practical levels and requirements difficult (3).

The same workers have recently reported on results with another amino acids diet which permitted growth rate of 11.5 grams per chick per day while a practical control diet supported a growth of 13.0 grams daily (4). The data on arginine conform remarkably closely to the Diminishing Returns principle (Fig. 1), showing a maximal response at 2.60% arginine hydrochloride (2.15% free arginine). The authors by a least squares method of data analysis have found 2.06% arginine. The diet contained over 38% amino acids, possibly equivalent to 36% of whole protein. On this basis the arginine requirement is about 6% of the dietary protein, as indicated in former reports.

Studies were made using a casein-cerelose-corn oil simplified diet with supplements of all known required nutrients except arginine. Chicks 7 days old were placed on diets with varying levels of added arginine. Growth improved with all levels up to the highest (2.38%). The basal diet, which con-

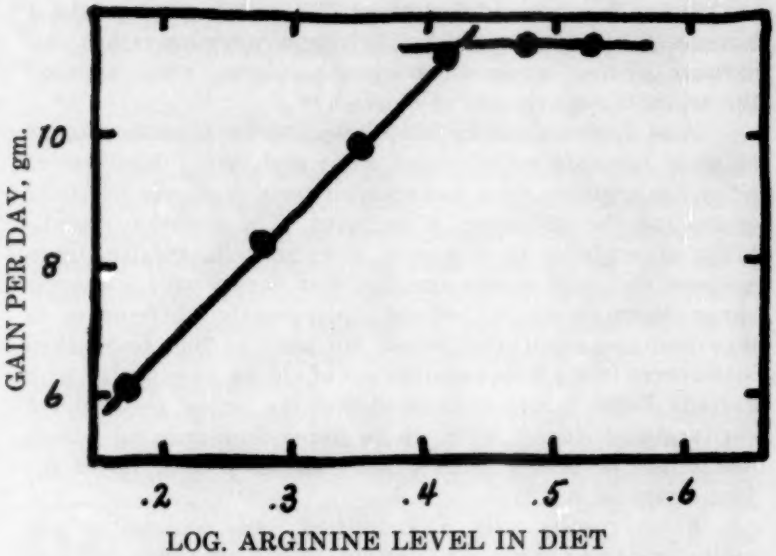

Fig. 1. Relation of chick weight gain per day to the logarithm of the arginine level in the diet. Application of the Diminishing Returns Principle. Constructed from data of Klain, *et al* (4).

tained no fiber or bulk, was greatly improved for growth by replacing some of the sugar with an inert fiber. In diets containing fiber the optimal total arginine was about 2.18%.

These diets contained at least 35% protein, which indicates that the arginine level in the protein, itself, was 6.2%. This is in good agreement with earlier estimates.

A valid reason for the use of protein levels so far from a practical range has escaped the reviewer.

On a casein diet deficient in arginine 3-week old chicks did not appear able to utilize proline, glutamic acid, or aspartic acid in the formation of creatine, for which arginine is a known precursor. Adult male chickens in a nitrogen balance trial could not use glutamic acid to replace arginine. Neither glutamic acid nor proline exerted any sparing effect on the arginine needs of growing or adult chickens, a fact which further confirms the completely essential nature of arginine for this species (9).

A simplified casein and carbohydrate diet for chicks was supplemented with other isolated protein and amino acids,

keeping the total N of the diet constant by replacing casein. Chicks were conditioned on a practical diet for 4-7 days before experimental use. Proteins were analyzed for arginine. A diet containing about 25% protein yielded best chick gains at an arginine level of 1.48%, (about 6% arginine in the protein).

A diet containing about 22.5% protein, 0.53% methionine and 0.06% cystine yielded maximal gains at 0.3% added methionine, or 0.89% total sulfur amino acids. This is equivalent to 0.8% sulfur amino acids in a 20% protein diet, in good agreement with prior estimates.

The arginine requirement of the chick was reduced by feeding thiouracil and increased by feeding thyroxine or iodinated casein. These compounds had no apparent effects on the methionine or glycine requirements. Proteins other than casein contained arginine which appeared to be more effectively utilized by the chick (10).

Proline. An amino acids diet for chicks was further improved by the addition of proline, indicating a semi-essential nature of this amino acid (5). Chicks on practical diets have responded with significantly increased growth when proline was added to the diets (6). Years ago it was reported that the omission of the prolines from a chick amino acids diet caused a lag in the rate of growth for several days, after which the chicks were able to resume growth, possibly after establishing a synthesis of the prolines (7).

Glycine. Using a diet of natural ingredients based upon corn and soybean oil meal, primarily, a significant improvement in growth rate of broilers following addition of glycine was observed when the basal diet contained added methionine hydroxy analogue. The fully supplemented 21% protein diet yielded better gains than 24 or 25% protein diets not supplemented with glycine and MHA. The data indicate that the glycine requirement under these conditions may have been higher than 1% of the diet (11).

Calculated glycine requirements may be rather uncertain because data on glycine content of feedstuffs are still incomplete and not highly accurate.

A series of practical broiler diets including simplified corn-soybean meal formulas was not significantly improved as a result of adding 0.20 to 0.25% glycine (12).

Methionine: A simplified diet consisting principally of

cerelose and soybean oil meal was supplemented with methionine and other amino acids. Soybean oil meal levels were varied by replacement of cerelose (which caused simultaneous deviations in energy and fiber content of the rations, as well as protein). Sulfur amino acids (methionine plus cystine) were adequate at 4.0% of the protein when the latter was 20% of the diet, in close agreement with estimates from other work. The percentage of total sulfur amino acids required in the protein tended to drop as the protein level increased, until 2.5% was apparently adequate at a 30% protein level (13).

As mentioned in a former annual report by the writer, there is evidence that when the caloric content of the diet is maintained at a high plane the required level of an essential amino acid in the protein does not necessarily decrease, or shows relatively less decrease, as the protein level increases.

Addition of other essential amino acids gave no growth responses. This is in agreement with a report issued years ago that the principal growth-limiting deficiency in the protein of soybean meal is that of methionine.

A sulfur amino acid deficient diet was improved for growth of both White Leghorn and Australorps by an addition of cystine. A methionine supplement increased the weight gain of the Leghorns but depressed the gain of the Australorps. In Leghorns the formation of cystine by liver tissue was increased by methionine injection but not in Australorps. The Australorps had, evidently, a metabolic block in the conversion of methionine to cystine, and the latter was an essential amino acid for this species (14).

A series of tests with methionine, protein and caloric variations in practical broiler rations was interpreted on basis of methionine requirement in relation to caloric content of diet. The assumed value for methionine in 50% soybean meal appears too high and the caloric value too low (12).

Actually the data show a distinct relation between optimal methionine level and protein levels of the diet, even when caloric level is disregarded. An analysis of the data by the Diminishing Returns method of the reviewer indicates the estimates of requirements on basis of all data. (See Figure 2.)

Phenylalanine and Threonine. It was reported that total phenylalanine plus tyrosine requirement of chicks was not over about 1.2% of the diet and that the threonine requirement was

FIGURE 2

Approximate Percent Protein in Diet	Approximate P. E. Calories Per Pound	Diet Optimal Methionine Level, Percent of Diet	Optimal Methionine Level Calculated to 20 Percent Protein Diet
21	990	.457	.438
23	1,100	.505	.435
25	1,060	.532	.426

between 0.55 and 0.60% in a 21% protein diet. Trials were run to 3 or 4 weeks using male chicks. The weights attained were, at best, only fair. In such cases there is a question whether some unrecognized condition or factor had imposed a ceiling on responses. No feed conversion data were given (15).

Lysine. It was estimated that fast growing chicks required 1.1% lysine in a 20% protein diet containing 975 calories of productive energy per pound. After 4 weeks the lysine level could be reduced about 0.05% per week to a minimum of 0.8%. Lysine requirement increased about 0.07% for each increase of 100 calories of productive energy or each 2% of protein (16).

An interesting study of the protein values of high and low protein sorghum grains for chicks has shown that the protein of the low-protein sorghum grain (10.5%) was superior in quality to that of the high-protein grain (15.3%). The proteins were deficient in lysine for the chick in both cases, but no supplementary effects could be noted from methionine, valine, isoleucine, glycine, threonine or arginine. Growth rates were small (17).

HEN

Methionine. S. C. White Leghorn pullets in individual cages were fed one of three basal diets of natural ingredients and similar energy content. Methionine hydroxy analogue was added to each diet, and in each case egg production improved distinctly.

It may be seen that each diet was deficient in total sulfur amino acids on basis of the NRC stated requirement of 0.53% in a 15% protein diet, and the requirements calculated by the reviewer according to the protein levels. The addition of the MHA brought the sulfur amino acid level above the calculated requirement level in each case. There should be no mystery concerning the fact that the 16.7% protein diet contained the

0.53% total amino acids specified for a 15% protein level yet was demonstratably deficient (18). (See Figure 3.)

FIGURE 3

Diet Protein %	Natural Sulfur Amino Acids %	Natural Sulfur Amino Acids Plus MHA %	Calculated Sulfur Amino Acids Required (Reviewer) %
14.7	.469	.536	.520
15.7	.503	.571	.555
16.7	.534	.601	.590

Threonine. Groups of S. C. White Leghorn laying hens in batteries were fed purified-type diets containing 7 to 8% casein plus amino acids to bring total equivalent of protein up to 12.5 to 13.4%. The diet was varied in threonine content. When production, weight maintenance and egg size were considered, it appeared that L-threonine requirement of the hen was approximately 0.42% of the diet. This amounts to 3% of the equivalent protein. The approximate requirement of the chick is also 3% of the protein at the 20% protein level (19).

Amino acids, general. By the use of amino acids diets and nitrogen balance or egg production studies the amino acids requirements of laying hens were estimated in the cases of isoleucine, leucine, lysine, histidine, glutamic acid, glycine and tryptophan. Requirements of others were estimated from the amino acid analysis of whole egg protein and by using lysine data as points of reference (20).

Previous studies by these authors have shown that qualitatively the essential amino acids for the hen are the same as for the chick with the exception that a need of the hen for glycerine could not be demonstrated. Both the chick and the hen require glutamic acid for maximal growth or egg production on diets of these types (21).

Hens were fed the minimal amino acid mixture in replacement of all protein for 3 weeks, and performed well. In addition to the listed amino acids the diets contained arginine hydrochloride 0.9, glutamic acid 3.5, glycine 0.5 and ammonium citrate 0.5%, the total equivalent to approximately 10% of crude protein. A 10% increase in all the amino acids improved egg production (20).

White leghorn pullets in lay were placed on diets of practical ingredients. Amino acids contents were calculated to meet minimal requirements as previously estimated with

a purified type diet and mixtures of amino acids. Body weight, egg weight and production, and feed efficiency were observed for seven 28-day periods. Eggs laid by hens on a 15.7% protein diet were consistently heavier than eggs laid by hens on diets of 10.4% and 11.3% protein. Production, body weight and feed efficiency were equivalent on the 15.7% and 10.4% protein rations, but inferior on the 11.3% protein ration (22).

The results are interpreted to mean that the essential amino acids required by hens can be provided in as little as 10.4% protein in the diets, however this is not intended as a fully adequate or practical level to be recommended for laying hens. Egg production exceeded 60% only twice, hence different conclusions might be obtained at higher rates of production. (See Figure 4).

FIGURE 4

AMINO ACID REQUIREMENTS OF HENS
(Percent of the Diet)

Reference number	20, 21 *	19	18	N.R.C.†
Arginine	+			
Histidine	.20			
Lysine	.55			.50
Methionine	.26			.28
Cystine	.18			.25
Tryptophan	.13			.15
Phenylalanine	.46			
Tyrosine	.33			
Leucine	.75			
Isoleucine	.55			.50
Threonine	.40	.42		.45
Valine	.59			
Glycine				
Glutamic Acid	+			
Protein, actual or equivalent	11	13.4	14.7	15.0

* The author's recommended minimal levels increased by 10% as listed by them.

† Revised (1959).

FIGURE 5

	Mg. Amino Acid Per Kilo Body Weight
Arginine	49
Histidine	23
Lysine	68
Isoleucine	70
Leucine	104
Phenylalanine	50
Tyrosine	35
Methionine	19
Threonine	44
Tryptophan	12
Valine	66

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FROM BARREN WASTE TO THRIVING INDUSTRY

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Having reached the stage where one month's receipts are now equivalent to six times the original cost of this hundred acre farm eleven years ago, it is interesting to look back on its gradual development over that period and up to this point.

At the time of purchase it was indeed a barren piece of bush land (Fig. 1), possessing comparatively little water in our dry summers, hardly sufficient grass to keep a dozen sheep alive and only three trees to provide shade against our blazing summer sun. Certainly a contrast to the present scene (Fig. 2), where besides the stream that gives the farm

Fig. 1 A view from the mountain at Clearsprings soon after clearing of the lower lands had begun in 1948.

Fig. 2. A view of Clearsprings taken from the slope of the mountain in 1956 before the lower portion had been developed with piggeries and California-type houses.

its name "Clearsprings", several boreholes yield all the water needed to support a green oasis studded by 4,000 Pinus Insignus, different varieties of Eucalyptus Gum and other trees, 45,000 head of poultry, a flock of sheep and a herd of Dutch Landrace pigs: not to mention the needs of several households for the 46 men required to work the farm.

The early years, when trying to make a start, were a struggle, when every setback was felt by the financial crises

that could come as a result of it and every hundred pounds sterling had to be made before buildings could be erected or brought up to date, while overproduction on our markets was a danger to our very existence.

Having come to this country from England and helped as manager, in the building up of a now prosperous poultry farm nearby, from where remuneration was still being drawn the first inclination was to avoid the day-old chick business from which that farm obtained most of its income. Such a course forced us to enter into the realms of an egg farmer and to build up a table bird plant, which turned out around 70,000 carcases a year.

It was not long however, before our breeding success in the commercial field, attracted those whose required day-old chicks for the same purposes as we did. The demand became exceptionally large for our chicks bred for laying purposes and table birds with the result that it soon became necessary to look upon our main business as breeders of commercial chicks for the egg farms and broiler plants.

It was always our aim to make this farm well balanced in that its source of income should not be derived solely through one commodity, such as eggs, broilers or chicks. We realized the danger of periodic gluts on our finances and that such a policy should be avoided at all costs. Today, therefore, our efforts are spread over the egg and table-bird business, the supplying of around 25,000 "near-lay" pullets a year, the

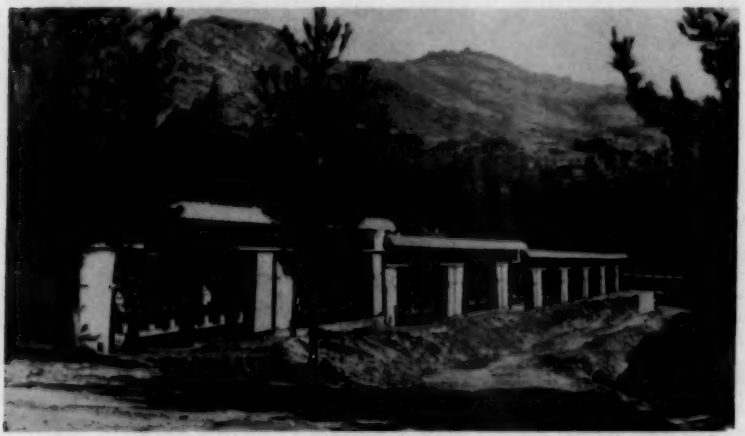

Fig. 3. Progeny testing of pure breeds is conducted in intensive houses, each section accommodating 35 pullets.

production of 600,000 chicks per annum, while much of our waste is disposed of through the medium of around 450 baconers sent to our local Cooperative in the course of a year.

Today our commercial eggs are only produced by our first-cross progeny testing units in laying cages and the young potential breeding stock in California-type laying houses. In fact we have no special commercial laying flock although we market around one million table eggs a year that are not required for hatching purposes. These eggs are sold ungraded and by weight to wholesalers in Cape Town. Being breeders we are not interested in making more out of our surplus eggs, which in any case mostly consist of out-size eggs, either below two ounces or above 2½ oz.

Because we always hatch more chicks than our orders demand, and pride ourselves in being able to accept any cancellations at short notice and also have quite a few thousand unwanted pure breed cockerels, we are still able to produce approximately 1,500 table-birds a week and keep many hen-battery people supplied with laying pullets throughout the year.

Fig. 4. Chicks are reared from 3½ to 7 weeks in battery cages in open front houses.

For the production of pullets that are destined for the numerous hen-battery plants the White Leghorn X Black Australorp is about the only cross-breed used. The cockerels of this cross-breed are equally popular by the broiler growers, because of their feathering and white flesh. The cockerels

of this cross do however sexually mature early and are, therefore, not the most economical for weights much over 3½ lbs. To meet the demand in this country that exists for the bird weighing between 4 and 5 lbs., live weight, we prefer the Light Sussex X Rhode Island Red, or the reverse cross which gives sex linkage. The Light Sussex used in these crosses is of a strain that has been bred only for the production of meat, while the R.I.R.'s to which they are mated are of a large-type laying strain that are not as quick feathering as we would like them to be. On our system and using no special broiler mash the cockerels of the first mentioned cross-breed reach 3½ lbs. liveweight average at about 9½ to 10 weeks old, while the LS X RIR and reverse cross cockerels reach 5 lbs. in weight at 13 weeks of age.

While our surplus pure breed cockerels are started on floor brooders and on grass ranges, and finished to 5 lbs. in weight on wire, our broilers are taken along, from day-old to killing weight, on wire only.

Being believers in a contrast of temperatures and plenty of fresh air for chicks, our brooder houses are fitted with an unusual amount of window space, ventilation and extraction fans, while the carry-on brooders, for chicks between 3½ and 7½ weeks old, are housed in open-fronted houses.

In our warm, and often damp, climate coccidiosis has forced many of us on to wire rearing or, for pure breeds, on to fresh rearing ranges. For this reason those birds required for heaver weights than 2½ lbs. are moved, again, from carry-on

Fig. 5. From 7 to 9, or even 13, weeks broilers are kept in coops with slatted floors.

batteries to outside finishing coops 3 ft. by 6 ft. by 2 ft. 6 inches high and designed to house 20 to 25 birds to 5 lbs. in weight.

On range the pure breeds are housed in well ventilated slatted floor arks 6′ x 6′ x 4′6″ high, eighty to one hundred in each until ready for the finishing coops, stud cockerel camps or laying houses.

Fig. 6. Open range is used for rearing of pure breeds.

Where laying houses are built concrete floors are used but, to avoid coccidiosis from damp litter, all floors are laid over two-ply roofing felt.

Our day-old chick business has developed beyond our most ambitious thoughts for it was never intended that it should become the most important side to our farming activities. Because nearly half our chicks have to travel by train or air to distances of between 600 and 1,000 miles the hatchery work has become most exacting. For chicks to travel well on journeys lasting 3 days and longer we find that not only must we produce the right chick but their hatching must be well timed to have them in just the right condition for particular trains and planes. In our case it often means four or five journeys to the stations, ten and sixteen miles away, to assure them arriving at their destinations in good fettle.

A big feature of this farm seems to have been an almost entire freedom from colds or roup of any description and no doubt any degree of success attained has been largely due to the efficiency thus enjoyed. The general good health of

the flock is attributed mainly to the entire segregation of all chicks, growers and any birds under 15 months old, from the old breeding stock. It is interesting in the light of present day knowledge, to have seen, from the PPLO test carried out on the farm, that what in fact we have been doing is to avoid any carry-over of PPLO from old birds to young until the latter are old enough to have built up a partial resistance to infection. In the young birds, under fifteen months old, no PPLO reactors were found whereas in the old breeders, where PPLO could have been brought through from year to year by contact, there was a 7.6% reaction.

While the balance of the farm remains in harmony with markets and the demands from its customers, there will be no desire to increase on any section. At the moment a slight increase is being made to the breeding flock and to the incubator capacity but only because of the expressed desire from certain customers that their orders should be increased as from four months time.

On all poultry farms, however, there seems no end to future development. If extra capacity is not desired then better ways for stepping up efficiency cause one to demolish or scrap old systems only to replace them by new. There can be no resting on success in the poultry industry, where to stop means to go back.

SELECTION FOR EGG PRODUCTION*

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I. INTRODUCTION

The science of Population Genetics is more widely applied to the breeding of poultry than to any other farm animal. The principles and practices of modern poultry breeding demonstrate therefore very well how genetics can be applied to animal breeding. As a matter of fact, two of the best books available on the Principles of Animal Breeding draw their material mainly from poultry (I. M. Lerner, 1950 and 1958).

* Outline of an address given to the Refresher School on Animal Production, Melbourne, September, 1959.

There are a number of reasons why population genetics could have been so successfully applied to poultry breeding:

1. Large populations can be kept economically under relatively well controlled environmental conditions, hence the data collected are particularly suitable to the statistical approach of population genetics.
2. The high reproductive rate of poultry allows breeding of both large Sire families (half-sibs) as well as Dam families (full-sibs). This permits high selection pressure applicable not only to the selection of Sires but also to Dams as approximately only 20% of the population has to be saved for breeding.
3. The interval between consecutive generations can be kept as low as one year by breeding from pullets, selected on their part annual performance which is closely correlated genetically to their annual performance.
4. The relative ease with which most economic characters can be accurately measured and recorded, and at small cost.
5. The specialization of the poutry industry into breeding farms, multiplication farms, hatcheries and commercial egg farms, which allows commercial egg farmers to replace their flocks regularly by buying chicks from a very small group of Stud breeders. These Stud breeding farms can then become so large, particularly by the system of franchising associated multiplication farms and hatcheries, that the full time employment of a Geneticist becomes economical. Some American breeding farms sell over 20 million chicks yearly and employ up to 5 Geneticists, in addition to other scientific staff.

There is however one difficulty encountered in poultry breeding which is caused by the fact that egg production is expressed by the female sex only. Hence, selection of the male has to be based exclusively on the performance of his female relatives (full- and half-sisters).

II. MEASUREMENT OF THE ECONOMICALLY IMPORTANT CHARACTERS

The correct measurement of all important characters is the first step in any breeding programme. The following characters can and are usually measured and recorded for the breeding of strains for egg production:

1. *Egg numbers* during the first laying year or part of it, and its components:

   Sexual maturity as expressed by age at first egg or in a population by its mean age when 50% egg production has been reached.

   Rate of lay or percentage of laying, which is determined by clutch size and interval between consecutive clutches.

   Pausing, i.e. intervals of more than 7 days between clutches of eggs (Frequency of pause and days lost).

   Broodiness (frequency and days lost).

   Persistence, i.e. later onset of the annual molt and therefore ability to lay for more than 12 months (age at or date of last egg).
2. *Viability*, or resistance to diseases of growing chicks and laying pullets.
3. *Hatchability*.
4. *Egg quality*, as determined by:

   Egg size, in particular the percentage of eggs graded into the different commercial egg weight classifications (samples only are weighed).

   Shell strength. Measurement of samples by the specific gravity test.

   Blood spots in eggs, measured as a percentage of eggs (by sampling) with detectable bloodspots at candling, or better by breaking of eggs.

   Albumen quality, measured by breaking a sample of eggs and determining Haugh Units (an index covering albumen height and egg weight).

   Colour of egg yolk, determined by breaking sample of eggs and by coding of colour according to a colour scale.

   Egg shape and shell colour.
5. *Body weight*. The smaller the layer, the better the feed/egg conversion rate, but eggs tend to become smaller also.

All these characters are heritable to different degrees and are of economic importance.

III. HERITABILITY OF CHARACTERS UNDER SELECTION

As the choice of an optimal breeding system depends largely on the heritability (h^2) of the character under selection, it is of great practical importance to have an estimate of the h^2 values of these characters. Broadly speaking, they

can be grouped into characters with high, medium or low h^2, as shown in Table 1.

IV. BREEDING SYSTEMS

The method used for selecting the future parents and the genetic relationship between the two selected parents determine the breeding system. Selection itself is influenced by two major decisions, viz.:

(a) Whether the future parent be selected on its own merits only (Mass selection), or on the merits of its family (half and/or full sibs), or by a combination of individual with family merits with proper weight given to each record. Of course, in the case of egg production, males can be selected only by evaluating their female relatives.

(b) Whether the parent be selected on the merits of one character only, or on a number of characters which can either be combined in a properly constructed "Total Score Index", or can be given consideration under the system of the "Independent Culling Level Method".

TABLE I

Average Heritability Estimates of Economic Characters in Egg Strains of Chickens (From Lerner, 1958)

Heritability	Character
High (> 40%)	Body weight, Egg size, Shell colour
Medium (20 - 40%)	Survivors' egg production, Blood spot incidence, Egg shape, Albumen quality, Shell thickness
Low (10 - 20%)	Rate of lay, Sexual maturity, Hen-housed egg production (Prod. Index)
Very Low (< 10%)	Persistence, Total mortality, Resistance to Leucosis, Resistance to respiratory diseases, Hatchability

Individual and/or Family selection: A combination of individual with half and full sib selection always gives the highest rate of genetic progress as shown in Table 2. However, full sib selection is costly, as it requires individual recording, pedigree matings and hatchings. Even individual (mass) selection requires costly egg recording for individuals, while pen recording for families of half-sisters (Sire families) is relatively cheap. This method is, therefore, to be recommended for characters with medium to low h^2 values, such as egg production (see Table 2). On the other hand for the few characters with high h^2 values, individual selection is superior to family selection.

TABLE 2

Relative Efficiency of Different Systems of Selection (where number of female offspring per dam (n) = 6 and number of dams mated to one Sire (d) = 8) From Skaller (1958)*

System of Selection	Relative efficiency of selection of females for a character under selection with:					
	$h^2 = 0.10$			$h^2 = 0.25$		
1. Individual (Mass-)	100			100		
2. Full-Sib	130	100		112	100	
3. Half-Sib	133	104	100	98	88	100
4. Index (combining 1, 2, & 3)	159	122	119	129	115	132

* Computed from formulae given by Osborne (1957 a & b).

However, individual recording is also a pre-requisite for pedigree hatching and full-sib selection. Hence, once individual recording is undertaken, it is worthwhile to make this more efficient by adding pedigree hatching. Furthermore, once individual records have been obtained as well as half sib and full sib family records, then this information should be combined in an Index to obtain the highest efficiency in selection. Osborne (1957, a & b) has published Tables which show the weighting to be applied to the mean recorded performance of full sibs and half sibs (according to the heritability of the character under selection and the number of individuals within the full or half sib family) to obtain the most efficient selection Index by combination with individual performance. Table 2 shows the relative efficiency of different systems of selection of females for a character of low and one of medium h^2 values.

Table 2 shows that within the range of h^2 valid for most characters contributing to egg numbers, family selection is always more efficient than mass selection, that the relatively cheap system of half-sib selection is slightly more efficient than the costly system of full-sib selection for characters with h^2 values of 10% or lower, and finally that combining all these three sources of information into one properly constructed index gives the highest possible rate of genetic progress.

Numbers of characters to be selected: If more than one character has to be considered in a selection programme, as is usual in poultry breeding where at least egg number, egg size and mortality must be considered, the selection intensity

for each character is lowered. The intensity of selection becomes $\sqrt[n]{v}$ for each character where n = number of characters under selection and v — percentage of population which has to be saved for breeding to keep the size of the population constant. In poultry the usual value of v — 0.20, which is equivalent to the intensity of selection if only one character were considered. But, if three characters are to be selected independently, the selection intensity for each of them will become equivalent to $\sqrt[3]{0.20} = 0.58$ and the selection intensity will decrease correspondingly.

The Index or Total Score Method assures maximum gains (Hazel and Lush, 1942) and its efficiency rises with the number of characters included. But, the construction of such an Index requires much detailed information on genetic parameters and economic weighting to be given. Few commercial breeders will therefore be able to construct a reliable index and will have to use the next best method, the Independent Culling Level Method which approaches the efficiency of the Index Method the fewer characters to be considered. In practice, one would fix minimum values for characters which have already reached a reasonable level, such as egg size, hatchability, shell strength, and concentrate selection on egg number as related to the number of pullets housed (Production Index) which gives some weight (though not the optimal one) to adult mortality.

Selection of Males: As egg production cannot be measured in males, their genetic value can be estimated only from the performance of their close female relatives, i.e. their full or half sisters, Osborne (Loc. cit) has provided tables which show how these two parameters can be combined by the use of correct weighting factors to give an Index with optimal efficiency.

Selection on part annual egg records: Biologically it is possible to have one new genetical generation of poultry each year. As one of the three factors determining the rate of genetic progress is constituted by the generation interval, it is desirable to keep this interval as short as possible, i.e. in the case of poultry, to breed from one year old females (pullets). Of course, this means that birds have been in egg production for up to 5 months only at the time selection has

to be made. Fortunately, part winter egg production is closely correlated genetically with annual egg production, and although some accuracy is lost by predicting the genetic value of a pullet for annual egg production on the basis of its part winter egg production records, more is gained than is lost by halving the generation interval. In conclusion, breeding from pullets, based on partial records, has been shown to be approximately fifty per cent. more effective in producing genetic improvement, as selection based on full annual egg production and breeding from 2 year old hens (Morris, 1956).

The relationship between the two selected parents: The parents to be mated together may be related to each other more closely than the average of the population (inbreeding) or less related (outbreeding), or they may on the average be neither more or less related than the average of the existing population from which they have been drawn (random matings).

There is general agreement between all workers that inbreeding in poultry depresses all characters connected with fitness, and in particular egg production, chick viability and hatchability, Skaller, 1956).

Outbreeding, on the other hand, results frequently in heterosis, and improvement in all those characters which inbreeding would depress. This method is, therefore, widely used in breeding of chicks for the commercial egg producer. Several methods are available.

(a) *Crossing between two or more different breeds*: Experiments have shown that the two most popular breeds in Australia, the White Leghorn and the Australorp, "nick" particularly well and give a large amount of heterosis, (Morris and Skaller, 1958), and some 2 doz. eggs more than the best of the parent strains used. A variation of this single cross is the criss-cross (Skaller, 1954) whereby purebred males of the two breeds are crossed back in alternate generations to the criss-cross bred females thus produced. This system has given the same amount of heterosis as single crossing and has some other economic advantages.

(b) *Crossing between inbred strains within the same breed* has also given excellent results (Incross or Hybrids). This method has been adopted for poultry from results obtained in the breeding of hybrid maize. A double cross

is usually produced for commercial purpose, and inbreeding is carried to four generations of full-sib matings. This system is very expensive during the development period, as inbreeding depresses nearly all economic characters and as the testing of as many combinations of strains as possible requires extensive facilities. An appropriate financial reward for these sacrifices during the development period can only be offered by a market with a very large potential as is the case in the USA. The method would seem to be impracticable for chick production in a country with a rather limited market, such as Australia.

(c) *Reciprocal Recurrent Selection*: In this method the improvement of the strains or breeds, to be used for crossing, is not based on the evaluation of their purebred offspring, but of the crossbred progeny from the different combinations tested. This method also requires facilities for the testing of as many strain combinations as possible, but the bad effects of inbreeding are avoided. Theoretically, this system tries to exploit, not only the additive genetic variation, but also variation caused by dominance and epistatic effects. Experiments at the Australian Poultry Research Centre and elsewhere indicate that Reciprocal Recurrent Selection is more efficient than the more economical system of family selection within one strain only if this latter system has resulted in a "plateau" which cannot be lifted by normal selection pressure.

V. NEW APPROACHES

As the rate of the spectacular genetic advances made in poultry breeding in the U.S.A. during the last decade has slowed down, new approaches are being tried out to overcome the problem of the genetic "plateau".

Blood group combinations: Perhaps the most promising new method is selection for certain blood group combinations. The present known blood group system in the chicken consists of 7 independently inherited systems, each carrying a number of polyalleles at a different locus and producing different antigens. Poultry can be "typed" for these antigens and consequently for the genes responsible for them. Hence, it is possible to produce poultry homozygous for the desired type of allele at each of these loci. It has been shown by

Briles, Irwin, McGibbon that birds carrying different blood groups were better adapted and also gave better egg production. Birds are now being produced carrying the desirable combination of blood types.

Selection under stress conditions: Another approach is to create variations by applying stress conditions and to select under such an unfavourable environment. Such stress conditions have been artificially created by overcrowding, manipulation of the light and temperature environment, by exposing birds to diseases and by restricted feeding, etc. Some encouraging reports have been published (1958, 11th Pacific Chicken Breeders' Roundtable).

Selection for correlated characters: Some characters, which can be measured and are heritable, are not of direct economic importance, though genetic correlations might exist between them and economically important ones. Sturkie *et al.* (1959) have recently shown that blood pressure in chickens is heritable and that low blood pressure birds showed lower viability than birds with high blood pressure.

Flock structure: If the size of a flock is given and also its reproductive rate, then such a population (P) can be maintained by a number of different mating schemes with the following variables. Number of sires (s), number of dams mated to each sire (d) and expected female offspring per dam (n) which depends on the length of the breeding season or the number of weekly hatches. Hence: $P = s.d.n.$

Now, whilst selection accuracy depends on the 3 factors h^2, d and n, genetic gains depend in addition to these factors determining accuracy, also on the intensity of selection (selection pressure), a flock's genetic variance, and the time interval between generations. The aim of the breeder is to maximize genetic progress by the correct application of all these factors. A mathematic model has been proposed to solve this problem (Morris and Binet, 1958) and tables for practical use are now being prepared from which a breeder can determine the optimal flock structure for improvements of characters with different h^2 values.

VI. POULTRY BREEDING IN AUSTRALIA

Up to a few years ago poultry breeding in Australia was based on Mass selection and little progress was made, with the result that commercial egg production fell behind

levels established in the U.S.A. by several dozen eggs per bird p.a. Recently, however, a change, comparable almost to a revolution, is taking place among Australian poultry breeders. This has been caused by the American example, the research and propaganda of Australian workers and particularly by the State Poultry Improvement Plans which are based on the results of the official Egg Laying Random Sample Tests which have substituted the old fashioned Egg Laying Competitions in all Australian States. The Random Sample Test conducted at Burnley by the Victorian Department of Agriculture is particularly well designed and conducted. Briefly, the principal of this and similar tests in other States consists in taking a representative and adequate random sample of fertile eggs from any poultry breeder who conducts scientifically designed breeding operations and who wishes to become an "accredited" breeder. These eggs are hatched and the chicks reared at the official testing station in a randomized group and tested for their economic value as egg producers in at least 2 pens allotted at random. The data are then statistically evaluated and permit judgement of the genetic quality of the commercially sold chicks, particularly if averages comprising a few years of testing are considered. The testing of a Control flock, supplied by CSIRO, is a further refinement to measure environmental variations between years, and between different State testing stations.

The Australian poultry industry is also becoming more integrated. Production units are becoming larger and Farmers with small flocks of less than 2,000 birds are finding it increasingly difficult to remain in the industry. Some of the largest breeding farms have combined for the purpose of employing a full-time Geneticist to direct all the breeding work, including the development of efficient strains of meat chickens ("broilers").

The still existing gap in egg production between the best U.S.A. poultry breeders and his Australian counterpart is closing rapidly. It can confidently be expected that the Australian Industry will, during the next decade, become as highly efficient as the American Industry. The decision to hold the 12th World's Poultry Congress in Australia, (Sydney, August, 1962) is a recognition of the position newly won for Australia by its efficient poultry industry and its high standard of poultry research.

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FERTILITY, HATCHABILITY AND EGG PRODUCTION OF POULTRY AT UNIVERSITY COLLEGE, IBADAN.

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The Poultry Section of the Department of Agriculture, University College, Ibadan was established in 1949 from a foundation flock of Rhode Island Red and Gold Legbar Chicks imported as day-olds from the United Kingdom. Subsequent importations included White, Brown and Black Leghorns, Black Australorp, Light Sussex, Barred Plymouth Rock, New Hampshire and Indian Game Fowl. Representative strains of the Nigerian fowl, guinea fowl, ducks and very recently turkeys were obtained locally.

During the past few years most of the work on poultry production in the College was aimed mainly at assessing the local management and disease problems prior to embarking on more applied experimental work. Accurate records were kept of production under different systems of management. The data presented in this paper were collected from records of the College poultry section from 1950-58.

MANAGEMENT AND FEEDING

Birds were housed on free range, in small, grassed runs, in hen yards, in batteries and on built-up-litter. The latter consisted of chopped, dried grass (*Cynodon plectostachyum*) or sawdust and compost. The majority of the laying flocks were managed semi-intensively, a comparatively small number being kept intensively. Shelters for birds housed out doors were roofed with dried grass, palm leaves, aluminum sheets or plywood. Permanent trees, including cocoa, citrus, cassia or teak, provided shade for birds.

Mashes for birds were formulated from available local feeding stuffs, and owing to scarcity of animal protein supplements, the bulk of the protein in the mashes was of vegetable origin. Apart from the occasional feeding of meat scraps from condemned carcasses on the farm, birds were fed mash mixtures containing 5% of a low-grade, pan-dried blood meal as the only source of animal protein (Table 1).

Cultivated, mixed grass and legume pastures of Giant Star grass (*Cynodon plectostachyum*) and *Centrosema pubescems* provided runs for birds kept semi-intensively. Natural

TABLE 1

Standard All-mash Mixtures Fed at University College Ibadan 1953-58

Ingredient	A General Purpose Layers & Breeders Mash %	B Growers Mash 12-14 Weeks %	C Chick Mash %
Guinea Corn (or yellow maize)	67	66	62
Palm kernel cake	9	11	6
Cowpeas*	3	4	8
Ricé Bran (or maize bran)	7	3	6
Groundnut Cake	5	7	8
Blood Meal	5	5.5	6
Salt (manganized)	1	1	1
Bone Meal	2	1.3	1.8
Oyster Shell	1	1.2	1.2
	100	100	100
Total % Crude Protein	20.17	21.83	22.40
Total % Nitrogen Free Extract	62.35	62.30	60.74
Total % Crude Fibre	5.65	4.45	5.10
Protein Equivalent	13.51	14.68	15.77
Starch Equivalent	71.02	72.19	70.68
Nutritive Ratio	1:5.3	1:4.9	1:4.4

* Or Bambara groundnut (*Voandzeia subterranea Thouars*), or Pigeon pea (*Cajanus cajan*).

Supplements:

1. Grass-legume meal or green feed supplements fed as available.
2. Palm oil and cod-liver oil supplemented each at 1% level for birds housed intensively.
3. T.O.C. vitamin supplements added during the dry season.

herbs and legumes for example, *Talinum triangulare* and *Tridax procumbens* provided additional green feed supplements particularly for the birds housed on built-up-litter.

Eggs were incubated in a Mammoth Secura and small, hot air, paraffin Glevum type incubators. Although the paraffin models were quite satisfactory, the forced draught Secura gave better results particularly during the height of the dry season when good control of ventilation and humidity was found essential for good hatches. Eggs were tested on the 18th day of incubation for "clears" and "dead-in-shells".

RESULTS

FERTILITY AND HATCHABILITY

Table 2 summarises the fertility and hatchability records at Ibadan for the period 1951-55. The figures presented are on flock basis, irrespective of breeds. This very low hatchability (51.8%) of all eggs set during this period was in part due to the fact that hatching was carried out throughout the year in an attempt to detect any seasonal changes in hatchery results. Although new breeding pens were set up at various times each year, it was unavoidable that some of the breeding

birds were kept working for longer periods and a larger proportion of older birds retained than would have been the case in a more restricted hatching programme.

The results however, indicate that the best fertility (68.7-80%) and hatchability of fertile eggs (77.5-90.5%) were obtained between the months of July and November, that is, during the mid-rains and early dry season, compared with a range of 61.8-67.8% and 63.4-75% for the same factors from December to June, that is during the dry season and early rains.

Fertility appeared markedly lowest (average 62.2%) during the three driest months from February to April. All "clears" at candling at 18 days were classed as infertiles although in some cases early embryonic development may have taken place. The high "infertility" may thus have been due partly to death of the embryo as a result of unfavorable environment in the early stages of development, particularly during the hot, dry months.

Breeding pens were set up between January and August in 1956 the hatching period in that year covering the height of the dry season and part of the rainy season. In 1957 the hatching period lasted from April to December covering the whole of the rainy season and early dry season. Since optimum and uniform conditions were maintained throughout these periods a comparative analysis of the results was made. This showed that the fertility and hatchability of all eggs set during 1956 averaged 75.0% and 58.1% respectively, compared with 77.8% and 66.4% for the same factors in 1957, which again suggests that optimum hatchability may be obtained during the wetter months, at least, at Ibadan.

Figures for "dead-in-shell" were high. In most cases embryos were developed to full term and died just prior to or immediately following pipping. The comparative absence of malformations or signs of disease indicates that this high percentage of "dead-in-shell" was due more to hatchery or climatic conditions than to any marked nutritional deficiency or other disease entity. Although not borne out by incubation results during 1951-55 (Table 2), there was evidence during 1956-57 hatching periods that a higher number of "dead-in-shell" occurred during the dry months of the year.

EGG PRODUCTION

Total egg production of imported and local breeds of

TABLE 2

All-year-round Hatching Trials at University College Ibadan, 1951-55

Month	Percent Dead in Shell	Percent Fertility	Percent hatchability of fertile eggs	Percent hatchability of all eggs	Total eggs
January	17.4	67.8	72.4	47.0	2,691
February	18.8	62.4	63.4	43.4	2,445
March	19.0	61.8	69.2	42.8	3,723
April	16.8	62.4	72.2	45.2	2,885
May	20.6	66.8	69.0	45.8	2,362
June	20.6	70.8	70.8	49.8	2,204
July	15.5	70.8	77.5	55.0	1,463
August	7.5	80.0	90.5	72.5	1,023
September	15.0	73.0	79.3	58.0	964
October	15.0	68.7	78.3	54.0	1,558
November	13.0	72.7	82.0	59.3	1,616
December	15.3	66.2	75.0	49.3	2,203
Average	16.2	68.6	74.9	51.8	25,137

fowl and duck for the period 1950-58 was 713, 372 eggs. Survivor averages for the entire flock ranged from 130-150 eggs per annum. Many birds continued in production throughout the moult period, although at a reduced rate. For example twelve Light Sussex birds in battery pen averaged 262 eggs over a continuous period of 810 days in the battery cages.

Egg production figures of second and third year layers represented as percentage of the egg production in the pullet year, were respectively 82-89 and 68-82 per cent. The calculations were based on survivor averages.

There are indications that the best production (survivor or hen-housed averages) were obtained in batteries. Production on built-up-litter was also satisfactory. Table 3 shows the percentage production of imported pullets and hens of all breeds in flocks managed extensively, semi-intensively or in batteries over a period of 6 years at University College, Ibadan. An egg laying trial was also conducted in 1958, with Light Sussex pullets to further compare egg production under different systems of housing. The average production, on hen-housed basis, for birds in battery, built-up-litter and semi-intensive grass pens were respectively 87.2, 77.1 and 68.0, for the six months period under test.

Rhode Island Red, Legbar x Rhode Island Red, Light Sussex x Rhode Island Red and Australorps x Rhode Island Red were the most vigorous layers. Pure Light Sussex and Australorp fowl did not perform as well as the crosses. The

Leghorns were too small for adequate comparison with other imported breeds and the imported strain used at Ibadan lacked vigour.

Excepting for a sharp drop in extensively managed birds in February the percentage of egg production in the College flock tended to rise with the approach of, and during the hotter, drier months, from November to early April, reaching a peak with the early rains in April and May. (Table 3)

TABLE 3

Percent Production of Imported Pullets and Hens in Flock of all Breeds managed extensively or semi-intensively or in batteries over a period of 6 years at University College, Ibadan

Month	Extensive or semi-intensive Percent Production	Batteries Percent Production
January	35.4	41.3
February	31.5	40.0
March	35.1	40.5
April	37.9	48.6
May	39.5	48.5
June	36.2	42.8
July	31.5	31.2
August	33.5	27.1
September	31.7	21.2
October	31.7	29.1
November	30.5	40.9
December	36.1	36.0
Total Eggs	352,398	28,217
Survivor average	130 eggs	140 eggs
Average % Production	35.5	38.9

This, what may be termed 'Spring flush' of eggs was followed by a general recession in production throughout the wetter months. The apparent optimum season (April-May) for egg production does not however, from existing evidence, coincide with the period of optimum hatchability, that is, during the mid-rains and early dry season, from July to November, which is in fact the period of lowest egg production. It is of interest to note also that peak production of eggs falls within the period of maximum hours of sunshine, namely, November to May.

Local and Local x Imported fowl: The local fowl under conditions leads a semi-wild existence and egg production is poor, averaging per annum about 40-80 eggs weighing 1¼ to 1½ ozs. The response of the local birds at University College Ibadan to more intensive management was good, the small, quite closely inbred foundation flock of 20 hens estab-

lished in 1952 and their progeny producing over 27,000 eggs by 1958. Survivor averages ranged from 66-124 eggs per annum, highest production being obtained in batteries, due mainly to a reduction in broodiness.

The progeny of selected local cocks crossed with imported pullets also gave good results, survivor averages being 140 eggs per annum. Incidence of broodiness in the crosses was high however, but was considerably reduced when the cross-breds were housed in batteries.

Egg Quality: Pullets of imported breeds tended to lay smaller eggs for a considerably longer period than occurs, but this may be explained in part by the fact that pullets up to the age of about twelve months were observed to be generally smaller than pullets of the same age and breed in temperate countries.

Egg grading figures for flock production for 1957 at University College Ibadan (Table 4) indicates a trend towards a higher percentage of small eggs laid during the hotter drier months, viz, from November to March. Egg grading results

TABLE 4

Egg Grading at University College, Ibadan, 1957

Month	Standard and large Percent	Medium Percent	Percent Small*	Total eggs graded
January	39.9	41.0	19.9	10,365
February	33.3	45.1	21.6	8,684
March	38.3	41.9	19.8	8,947
April	46.2	38.6	15.2	9,758
May	47.7	37.2	15.1	8,216
June	53.0	34.5	12.5	9,019
July	50.5	35.9	13.6	8,946
August	50.8	35.2	14.0	8,634
September	51.3	36.1	12.6	7,149
October	53.7	32.8	13.5	7,028
November	33.4	36.4	30.2	6,806
December	35.0	44.5	20.5	13,616
Total	47,085	41,595	18,488	107,158
	5.5% Large			
	38.3% Standard	3.8%	17.2%	

* Includes Local fowl eggs.

of hens kept under different management systems for the period 1955 to 1958 show that a higher percentage of standard and large eggs were laid in batteries or on built-up-litter. The average egg weight and percentage large and standard eggs of birds in batteries, built-up-litter and semi-intensive pens were respectively 1.84 oz. and 51.48%; 1.83 oz. and 50.82%; 1.79 oz. and 19.93%.

This suggests that the increased number of smaller eggs laid by birds managed on range or semi-intensively may have been due more to climatic than to any marked nutritional stress. It is to be noted however, that on a flock basis, the total of 43.8% for standard and large eggs does not compare favourably with averages of eggs of similar grades for commercial flocks in the temperate countries. The figure quoted for commercial flocks in the United Kingdom, for 1958 for example, was approximately 90%, 50% large and 40% standard. (private communication).

Pure Rhode Island Red and crosses of Rhode Island Red with Australorp and Light Sussex were consistent in producing good sized eggs. The strains of Leghorn fowl used also laid large eggs, but texture appeared poor. The Ibadan strains of Light Sussex appeared to lay the smallest eggs in comparison with other exotic breeds. Eggs of local fowl, whatever the system of management, were small in size but of consistently good shape and texture. No work has as yet been done on internal egg quality at Ibadan but yolk and egg-white quality were in general of good appearance, consistency and flavour.

DUCKS AND GUINEA-FOWL

The small foundation flock of Muscovy ducks, established at the College in 1954 responded well to improved management. These birds and their progeny have since produced 8,000 eggs. The duck breeding pens consisted of small grass runs, with thatched houses and wooden, earthenware, or basket nest. Small ponds made of half 44 gallons petrol drums, or concrete troughs were provided. Birds were fed layers' and breeders mash, but when adequate scavenging and grazing could be provided mash feeding was reduced to a minimum.

Each clutch averaged 10-16 eggs weighing 1.7-.1.8 ozs. Hatchability under natural conditions was 72.1% of all eggs set.

Another breed of ducks, the Badagry whose name derives from a coastal town of Badagry in Nigeria where these birds are commonly found was maintained at the College. Egg production of these ducks was good the best pens averaging 220 eggs weighing 1.82 ozs. in 457 days. Because they lack broodiness, their eggs were set under the domestic hen. Fertility was low, hatchability of all eggs set being 58.4%.

A small flock of the grey-breasted Helmet Guinea fowl —*Numida Maleagris galeta* was kept at Ibadan from 1952-55. The hens were active layers during the height of what appeared to be their breeding season, from May to July, but production was too low to warrant their being fed for the remainder of the year.

SUMMARY

The work of the Poultry Section of the Department of Agriculture, University College, Ibadan during the period 1950-58 is described. The flock consisted of Rhode Island Red, Legbar, White, Brown - and Black Leghorn, Black Australorp, Barred Plymouth Rock, Light Sussex, New Hampshire and Indian Game fowl as well as local strains of fowl, guinea fowl and duck.

Birds were managed extensively, semi-intensively and intensively. Mash mixtures were formulated from feeding stuffs available locally. Pan-dried blood meal formed the only source of animal protein.

The average percentage Hatchability figures of all eggs set for the periods 1951-55 and 1956-57 were respectively 51.8 and 62.2. Average percentage fertility figures for the same periods were 68.6 and 76.4 Maximum fertility and hatchability which did not coincide with optimum egg production, were obtained between the months of July and November, during the mid-rains and early dry season.

Survivor averages for imported breeds ranged from 130-150 eggs per annum for the flock. Results indicated that higher egg production was obtained under intensive systems of management, batteries and built-up-litter, best results being obtained in the batteries.

Under conditions of improved husbandry methods the egg production of the local fowl increased from 60-80 per annum to 80-90 for birds managed semi-intensively, and 124 eggs per annum for birds in batteries. Best survivor average of local x imported fowl was 140 eggs per annum and was obtained in birds managed intensively.

The period of maximum egg production coincided with the period of maximum hours of sunshine, that is from November to May.

The smallest eggs were laid during the hot dry months from November to March particularly under semi-intensive or extensive systems of management. The highest percentage

large and standard eggs was obtained in birds managed intensively.

The local Muscovy and 'Badagry' ducks responded well to intensive and semi-intensive management. Egg production for the Muscovy averaged 60-80 eggs weighing 1.7-1.8 oz. per annum. Best pens of 'Badagry' ducks averaged 220 eggs weighing 1.82 ozs. in 457 days. Hatchability for the Muscovy under natural conditions was 76.1% of all eggs set and for the Badagry under natural or artificial conditions 58.4%. Egg production in Helmet Guinea Fowl was very seasonal, being limited mainly to the months of May and July.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to the staff of the Poultry Section, Department of Agriculture, University College, Ibadan for looking after the flock and for keeping the records which provided the data for this paper. Information, on egg grading of commercial flocks in United Kingdom supplied by Mr. H. R. Harvey, General Secretary, Poultry Association of Great Britain, is acknowledged with gratitude.

IMPORTANT INTERNATIONAL AWARD

The Secretary (Mr. John R. Harvey, F.C.I.S.) of the Newman Trust International Poultry Award announced that the Award Committee in the United Kingdom has decided that the 1959 Award shall be made to Professor F. W. Hill, Professor of poultry husbandry, Cornell University, Ithaca, New York. The Award was made to Professor F. W. Hill for his outstanding work in poultry nutrition published in 1958. There were submissions this year from the Union of Soviet Socialist Republics, Canada and the United States of America.

The Award was instituted some years ago by Poultry Association of Great Britain and has been won seven times by U.S.A. Research workers and three times by United Kingdom workers. Several other countries are concerned in the Award but the Award has not as yet gone elsewhere so far, other than to the U.S.A. or the U.K. There are Corresponding Secretaries in touch with the Award Secretary in Great Britain in every country where poultry husbandry has been developed into an industry.

The Award consists of a handsome medal and £50 sterling. It is given for what in the opinion of the Award Com-

mittee, meeting in the United Kingdom, is the most important contribution to poultry husbandry research work published in the previous year, for the benefit of poultry husbandry.

Among the members of the Award Committee in the United Kingdom are Dr. H. Temperton, J. P., N.D.P. (National Institute of Poultry Husbandry, Shropshire); Mr. E. T. Halnan, M. A. (of Cambridge) and Mr. Michael Pease, M. A. (of Cambridge).

THE CANADIAN POULTRY BREEDING AND HATCHERY INDUSTRY

A. S. JOHNSON

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The growth of the Canadian poultry industry in the last few years has been accompanied by a changing pattern in hatchery and breeding operations. A greater recognition of improved strains of chickens and turkeys is evident. At the same time there has been a decided increase in average hatchery size, coupled with a decrease in their total number, and certain changes in the pattern of chick production and customer service. While these two facts seem quite unrelated, they are both reflections of a trend to greater efficiency and more exacting requirements on the part of poultry producers.

The "franchise" hatchery system in Canada has evolved as a result of the large-scale entry of strains developed by breeding farms in the United States. These organizations, which already have a stream-lined system of selling and advertising, have made contracts with hatcheries meeting their standards for the distribution of their stock in certain areas. A typical arrangement would be to place males of one line of breeding and females of another line in the supply flocks of the franchised hatchery; the hatchery would then offer chicks from the final cross (for example, two or more strains of a given breed) to the public but would be unable to reproduce the strains as such. These Canadian hatcheries have thus taken in the role of propagators and distributors without having any stake in a breeding program themselves. To some extent at least, their sales and promotion programs have been outlined for them. Largely as a result of this franchise de-

velopment, producers have become conscious of the use of improved strains as never before. The net result has undoubtedly been beneficial to the over-all chicken and turkey industry. It does, however, present a serious challenge to present and future breeding enterprises in Canada.

Most hatcheries in all provinces are registered under a national hatchery program (mandatory in all except two). The distribution of hatcheries by province is shown in Table 1.

TABLE 1

Distribution of Registered Hatcheries by Province[1]

Province	1954-55		1957-58	
	Hatcheries (No.)	Total capacity	Hatcheries (No.)	Total capacity
British Columbia	103	4,348,344	63	3,743,366
Alberta	62	4,940,604	60	5,560,029
Saskatchewan	60	4,655,056	58	4,746.428
Manitoba	74	5,273,607	70	5,782,519
Ontario	263	12,425,075	229	14,799,827
Quebec	74	3,721,206	65	4,300,384
New Brunswick	35	609,566	24	491,008
Nova Scotia	23	775,667	23	901,768
Prince Edward Island	12	320,600	10	279.220
Newfoundland			1	13,000
Total	706	37,069,725	603	40,617,549

[1] Figures courtesy Poultry Division, Production Service, Canada Dept. of Agriculture.

The marked trend toward fewer and larger hatcheries is shown by a comparison of the 1957-58 figures with those for 1954-55. More than in the past, hatcheries are selling only one or two strains (or strain-crosses) of chicks or poults. A limited number, in both chick and poult production, are breeder hatcheries, distributing their own strains. Hatchery supply flocks, for the production of hatching eggs, are inspected and approved under provincial flock approval programs. The main basis for flock approval is the incidence of reactors to a blood test for pullorum disease, which must fall below a certain specified level (in several provinces 1 per cent). In addition, certain other health and management standards may be required. The provincial programs as such do not contribute in any way to the genetic improvement of poultry through their flock approval regulations.

SCIENTIFIC DEVELOPMENTS

A number of scientific developments have contributed to a sounder program of hatchery operation. Egg-holding and incubation procedures have been greatly improved. Special in-

cubation methods have resulted in satisfactory hatching of eggs of other species, such as geese. The technique of vent sexing of chicks at hatching time has been a real boon, in the case of egg-production stock particularly, where the male chick is of no value other than in a breeding program. The management of the flock producing the hatching eggs has come in for much closer scrutiny. Accordingly, blood testing was developed for the removal of carriers of the Salmonella pullorum organism. Programs to reduce the likelihood of transmission of other egg-borne diseases, such as chronic respiratory disease, have received consideration.

Nutrition of the breeding flock is now sufficiently well understood to present few major problems. Of some concern are the management conditions needed for satisfactory year-round hatching. The most promising single item in this picture is the use of controlled lighting. It may be the answer to improved "out-of-season" reproduction; already it has proven to be the major factor required for summer and fall production in turkeys and thus will provide even greater stimulus to turkey broiler production. Artificial insemination, particularly of turkeys, is a useful technique, and one which could be used even more to overcome low fertility, thus making a reduction in poult price possible.

R.O.P. POLICY

If a hatcheryman seeks to improve the quality of the stock he distributes, he can do this in either of two ways. He can develop his own breeding program to this end or he can seek the product of a breeder who is engaged in breeding and selection. Apart from experimental work in poultry breeding at research institutions, all commercial breeding of chickens in Canada which involves selection for egg production has originated under the Record of Performance Policy of the Production Service of the Canada Department of Agriculture. Breeding flocks under this policy are certified on the basis of a certain standard of production. This permits them to sell certified stock which then generally finds its way into the hatchery supply flocks. The R.O.P. program, at it is called, contributed, particularly a few years ago, an appreciable proportion of the genetic material for the hatchery supply flocks. Under this program, breeders are currently engaged in strain-crossing and testing in an attempt to develop superior stock for distribution. Some strains of chicken broilers

and turkeys, mass-selected for growth rate and conformation without getting pedigree information on traits such as egg production, have been originated independently of the above program. The limitations which apply to small breeders and their chances for success have undoubtedly been factors in the steady decline in the numbers of poultry breeders in Canada in recent years.

RANDOM SAMPLE TESTS

Within the past 5 years a Random Sample Test has been established, supervised by the Production Service, Canada Department of Agriculture. Several of these tests are also in operation in the United States. They are one of the safeguards the chick buyer has, to avoid being sold a strain on the basis of advertising and a "trademark" only, rather than on actual genetic quality. Samples of commercial strains are tested in a uniform environment to permit more accurate comparisons. To ensure maximum control of the environment, hatching eggs are brought in for each strain and incubated together. The growing chicks and adult stock are either reared together or randomized by strains throughout the test facilities. Pertinent data are obtained on traits of economic importance, such as mortality, feed consumption, egg production and egg quality. The final results usually include a figure for net revenue based on the calculated income (producer price) for eggs plus the meat value of the birds at the end of the test with cost of chicks, feed and other items deducted. Published with the names of the breeders, they provide chick buyers with a means of evaluating the relative economic worth of the different strains and in addition give breeders information on their own strains in competition with others. Research has indicated that test results showing strain ranking for different traits in one part of the country should be applicable in other areas. Apart from the foreign entries, the entrants in the Ottawa egg production test are participants in the National Breeding Program. A chicken broiler test is also conducted to compare growth rate and other characteristics of broiler strains.

In addition to the above-mentioned Central Random Sample Test of egg production stock at Ottawa, there are at present two provincial tests, in Alberta and British Columbia. Their policies and operation are somewhat similar to those of the Central Test and there is a degree of coordinated

approach to their problems. Provision is made in the three tests for entry of some of the American strains being sold under franchise.

U.S. PICTURE

To understand the problems facing Canadian poultry breeders, it will be necessary to discuss what is happening in the same field in the United States. A significant proportion of the stock now being sold in Canada (chickens and turkeys) comes from American sources. In the egg production industry, development of this trade has come about largely within the last 10 years. It is confined to the strains produced by about eight to ten different breeding organizations, of which four contribute, according to the figures available, about 70 per cent of the total. There are indications that at present these American strains account for at least 40 per cent of the White Leghorn or "light-breed" chicks which are sold in Canada.

It is important to realize that the above eight to ten strains also represent, in volume of chicks sold, the top egg production strains in the United States, where the total poultry population is many times the size of that in Canada. Reports show that in 1958 Canada produced 61 million replacement chicks for laying stock, as compared with 598 million in the United States. In the American chicken broiler industry, which in terms of chicks hatched in 1958 is roughly three times the size of the egg industry, the dominance of a very small number of breeders, or breeding organizations, is even more pronounced. There it is estimated that 70 to 80 per cent of the commercial broiler production is comprised of three strains, or strain-crosses. Thus it is significant that, in an industry as large as that in the United States, the market is dominated by a relatively small number of breeders. This development began due to breeders having the foresight and sufficient "know-how" to do the best possible job for the future. They had at least one other important asset, a business organization with a sales and service program designed to take maximum advantages of progress in breeding. Particularly in the broiler field, the latter, of late, has played a significant part.

NEW TECHNIQUES

Almost all of these breeders could be considered pioneers in the effective utilization of available genetic knowledge in poultry breeding. In recent years, having recognized the technical progress which has been made in genetics and related

fields, most of them have employed "top-flight" geneticists, pathologists and management personnel to develop their programs further. They use modern electronic equipment for summarizing and analyzing their vast quantities of breeding and experimental data. Some of them have adapted new breeding techniques, in some cases developed in other fields, such as corn breeding, to poultry.

One could say, therefore, that the important bredeers in the United States experienced two phases in their growth, a *development* and an *expansion* phase. These varied in length, depending on the capital behind them. Currently, competition among these breeders is extremely keen in both Canada and the United States, and chick sales are influenced considerably by the promotional features used to capitalize on the evidence of genetic quality of the strain. Thus, a new breeder without strong financial backing has extreme difficulty in becoming competitive. Not only must he have a strain of birds which is in the competitive range, but he also has to have a production and promotional organization capable of achieving reasonably large sales. The importance of this aspect of the operation is indicated by the fact that "breeders' schools", organized annually by industry and technical people, have begun to devote part of their programs to promotion and sales, in addition to the technical aspects of poultry breeding.

The significance of this to the Canadian industry is due to the fact that most Canadian breeders are in what has been called the *development* phase; yet they are competing in Canada not only with each other but also with the American strains. While some of them may have reached certain creditable levels with respect to the quality of the strains or straincrosses of egg-laying stock, broilers and turkeys which they have developed, the number who are in a truly competitive position is disappointingly small. For every one of these, there are many, particularly in some of the less dense poultry areas, who have not yet felt the pressure of competition sufficiently to realize that time is running out.

In reaching the above conclusions, some distinction should be made between breeders of different species of poultry. Turkey breeders, in general, have nowhere made the same progress in the use of advanced techniques as have chicken breeders. To only a limited extent (in many cases not at all) have they utilized pedigree selection, reciprocal recurrent selection, strain crossing, selection indices, and some

of the other devices which are the tools of the more advanced chicken breeders. There is thus, for a limited time only, an opportunity for Canadian turkey breeders, particularly those who would seriously attempt to attack the major problem in today's turkey breeding, that of reproduction.

FUTURE PROSPECTS

That Canada does not draw a complete blank with regard to her possibilities in poultry breeding is illustrated by the fact that in the 1957-58 results of the Canadian Random Sample Test of egg-laying stock, in which two of the top American breeders had entries, Canadian strains ranked first, second, third and fifth, based on net revenue as calculated for this test. Thus it does seem that certain Canadian breeders could develop effective competitive organizations if they set out to do so. It is of interest that one of our progressive breeders has already established several franchise hatcheries for distribution of his stock both in Canada and the United States.

While future developments in poultry breeding and hatchery operation cannot be predicted with complete accuracy, they are likely to be influenced by certain characteristics of the production industry, as they have in the past. It is conceivable, for example, that integration of parts of the industry could make competition even more difficult for small breeders and hatcheries. A study of the current poultry industry will surely convince anyone that its progress in recent years has been tremendous. It then becomes axiomatic that those of its segments which wish to remain competitive must advance with it. (Reproduced from the Agricultural Institute Review, Ottawa, Canada, March-April, 1959).

AUSTRALIAN BRANCH SUBSCRIPTION
(A Correction)

The green-colored insert in the October-December, 1959, issue of the Journal contained an error regarding subscription fees for the Australian Branch of W.P.S.A.

The Australian Branch Subscription fee which includes membership of W.P.S.A. is 30/-. Australian currency A. O. Moll, 89 Quay Street, Syndey, is the Branch Secretary. Members in Australia should forward their subscriptions to Mr. Moll.

In Memoriam

Dr. Morey A. Jull, 6906 Pineway, University Park, Hyattsville, Maryland, U.S.A.—Joined the World's Poultry Science Association in 1913. Member of Council for U.S.A. from 1949 through 1958. Chairman of the Publication Committee of the World's Poultry Science Journal from 1945 to 1949, and an active contributor to the Journal from its inception.

Joseph William Kinghorne, 1365 Iris Street, N.W., Washington 12, D. C., U.S.A.—Joined the World's Poultry Science Association in 1947. Member of Council for U.S.A. from 1949 to 1952. Vice-president for U.S.A. from 1952 to date. Member of Publications Committee of the World's Poultry Science Journal from 1945 to 1947, Chairman from 1947 to 1949. Compiled the Review of Poultry Publications for the Journal from 1949 to date.

REVIEW OF POULTRY PUBLICATIONS

(Abstracts from Animal Breeding Abstracts and from *Nutrition Abstracts and Reviews* are reproduced by arrangement with the Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England.

Acknowledgment is also made to Biological Abstracts, University of Pennsylvania, Philadelphia 4, Pennsylvania, U.S.A. for the abstracts taken from *Biological Abstracts.)*

GENETICS

JEROME, F. N., and C. M. HUNTSMAN. (Ontario Agric. Coll., Guelph, Canada.)

A GYNANDROMORPH WHICH AROSE FROM A SEX-LINKED CROSS. Poultry Sci. 38(3): 727-731. Illus. 1959.—This bird arose from a cross of New Hampshire males with Barred Rock females. It carried the barred plumage color of the male crossbred on the right side and the nonbarred plumage color of the female crossbred on the left side. An autopsy of the adult bird showed a normal testis on the right side and ovarian tissue on the left side. Mature spermatozoa were present in the testis; maturing yolks were present in the ovarian tissue. An oviduct was also present. (Biological Abstracts)

MATSUDA, YOSHIO, and IWAO IWAMURA. (Fac. Agric., U. Miyazaki, Japan.

CHEMICAL STUDIES ON THE FERTILITY AND SEX DIFFERENCES OF EGGS. I. THE RATIO OF ARGININE TO TRYPTOPHANE IN FERTILIZED AND NONFERTILIZED EGGS OF DOMESTIC FOWL. [In Japanese with English summ.] Bull. Fac. Agric. Univ. Miyazaki 1(2): 196-200. 1956.—The average molecular ratio of arginine to tryptophane was 100:73 for fertilized germinal discs and 100:69 for nonfertilized. The ratio was 100:74 for fertilized egg yolks and 100:75 for nonfertilized egg yolks. The amount of arginine in the HCl acid-hydrolysates of fertilized germinal discs was 1.52%; for nonfertilized germinal discs 1.41%, calculated on a wet basis. (Biological Abstracts)

SEBESTYEN, G., and I. MORVAI.

DATA ON THE HERITABILITY OF SOME QUALITIES OF PRODUCTION OF THE HUNGARIAN YELLOW FOWL. (Adatok a sarga magyar tyuk ertekmero tulajdonsaginak atorokleschez.) Allattenyesztes, Budapest, 1958. 2. pp. 149-154.

The authors examined sexual maturity, egg production in winter and intensity of the egg production in the breeding stock of Hungarian yellow hens in the State Farm at Felsobabad. According to their results no noteworthy difference exists between the early and late hatched hens as regards the heritability of sexual maturity. Their examinations were conducted with the paternal half-sister method and with the full-sister method. It was found that the full-sister method is more suitable to assess the heritability of the fowls' production qualities. During the examination of a total of 1632 Hungarian yellow hens the h^2 value of sexual maturity was found to be 0.20, 0.27 and 0.28, the h^2 value of egg production in winter in 1456 hens was 0.21 and 0.23 and the h^2 value of egg production intensity (i. e. of the average length of the cycle) of 758 hens was 0.65. Thus the h^2 value of egg production intensity considerably exceeds the values found by other authors. In the authors' opinion this may be explained by the fact that a stock closely selected

for this property was used in examinations, so that this result may have a validity only for this examined material. According to the authors' conclusions, on account of the small h^2 value selection for the properties mentioned can be made only with little efficiency on the basis of the phenotype. The adoption of family breeding is considered more opportune and advisable for the breeding of these properties, which are in close correlation with egg production. (Hungarian Agricultural Review)

QUICKE, G. V., and **H. J. H. de MUELENAERE.** (U. Natal, Pietermaritzburg, S. Africa.)
STUDIES ON THE BIOCHEMISTRY OF COCK SEMEN. 3. DENSITY MEASUREMENTS OF SEMEN. [In English with Afrikaans and French summ.] S. African Jour. Agric. Sci. 1(3): 289-292. 1958.—No correlation was found to exist between hemocytometer counts of sperm and the optical density measurements of whole cock semen, but a positive correlation was found to exist for washed cock semen. It is postulated that this discrepancy is due to the fact that semen is contaminated by fecal restants or other cloacal excretions during the ejaculatory period. Optical density measurements appear to give more reproducible results than hemocytometer counts. (Biological Abstracts)

PHYSIOLOGY

HENDERSON, EARL W. (Michigan State U., East Lansing.)
SEX INDENTIFICATION BY DOWN COLOR OF SILVER LACED AND "RED LACED SILVER" CHICKS. Poultry Sci. 38(3): 599-602. Illus. 1959.—Efficiency of distinguishing sex of day-old chicks by down color (autosexing) was tested from 2 Silver varieties. "Autosexability" among progeny of Silver Laced "mutants" mated inter se was 76%, (Chi-square, 15.3). Among progeny of Red Laced Silver "mutant" females by Red "Gold" males, efficiency of identifying sex of chicks was 73% (Chi-square, 40.5). (Biological Abstracts)

MIMURA, HAJIME, KEIZO OKAUCHI, and **SEIGO TAMADA.**
STUDIES ON ABNORMAL EGGS OF DOMESTIC FOWL. 1. DWARF EGGS LAID IN BARNS. [In Japanese with English summ.] Bull. Fac. Agric. Univ. Miyazaki 2(1/2): 63-72. 1957.—The authors studied 110 dwarf eggs of White Leghorn, Barred Plymouth Rock, Rhode Island Red, and Nagoya. All eggs were provided with shells, ranged from 4.4-32.5 g in weight. The average weight was 15.5 g. Most numerous were those of 10-15 g weight. The egg shape index was the lowest in the group ranging from 20-25 g in weight. The yolk was absent in 8% and chalazae absent in 33%. The percentage of the yolk to the whole egg was smaller than normal eggs. Albumin, shell, and shell membrane were larger in percentage than in normal eggs. All were formed around nucleus material which was either a yolk, albumin or blood clot. Yolk was the nucleus in 92%. Even when the yolk was central it was rarely complete in structure. In most instances it was fragmentary. Foreign matter was more frequently encountered in dwarf eggs than in normal ones. Chalazae were often irregularly shaped. The incidence of dwarf eggs was 4 per 10,000. Usually a hen laid a dwarf egg once a year. No propensity of dwarf egg laying was observed. The height of dwarf egg laying was a little later than the height of normal egg laying. Dwarf eggs seemed to be formed by abnormality of the nucleus, and smallness of the nucleus. (Biological Abstracts)

MUELLER, W. J., and **A. AGUILERA AMEZCUA.** (Pennsylvania State U., University Park.)
THE RELATIONSHIP BETWEEN CERTAIN THYROID CHARACTERISTICS OF PULLETS AND THEIR EGG PRODUCTION, BODY WEIGHT AND ENVIRONMENT. Poultry Sci. 38(3): 620-624. 1959.—Seventy-one Single-Comb White Leghorn pullets were used to

investigate the effect of environmental temperature and relative humidity on rate of disappearance of I^{131} from the thyroids, dose of injected L-thyroxine necessary to arrest I^{131} secretion, and thyroid weight. In addition the relationships among the 3 thyroid characteristics, egg production, and body weight were studied. Pullets kept at 85° F and 70% RH (relative humidity) from 174 to 450 days of age had smaller thyroids and needed less injected L-thyroxine to arrest I^{131} secretion than pullets kept at 55°F and 70% RH. On the other hand, pullets kept at 85°F and 70% RH secreted I^{131} significantly more rapidly than those kept at 55°F and 70% RH or 85°F and 25% RH. From this discrepancy and other evidence, it was concluded that rate of I^{131} secretion and dose of L-thyroxine necessary to arrest I^{131} secretion probably measure 2 distinct physiological characteristics. Both I^{131} secretion rate and dose of injected L-thyroxine necessary to arrest I^{131} secretion, were correlated with egg production during the 13 days following I^{131} injection. Body weight was only correlated with thyroid weight and there were no significant correlations among the 3 thyroid characteristics. (Biological Abstracts)

OKAUCHI, KEIZO.
ANATOMY OF THE OVIDUCT OF DOMESTIC FOWL; WITH SPECIAL REFERENCE TO PERFORATION OF OCCLUDING PLATE SITUATED AT END OF OVIDUCT. [In Japanese with English summ.] Bull. Fac. Agric. Univ. Miyazaki 3(1/2): 119-123. 1958.—Histological and anatomical studies showed that the perforation of the occluding plate took place at around 140 days after hatching in pullets of normal development. At the time of perforation, the ovaries weighed about 1.5 gm, the largest follicles having diameters about 7 mm and the oviducts weighing about 13 g. (Biological Abstracts)

OKAUCHI, KEIZO, and **MASAO KUROKI.**
A CASE OF OVIDUCTS ON BOTH SIDES IN THE ADULT DOMESTIC FOWL. [In Japanese with English summ.] Bull. Fac. Agric. Univ. Miyazaki 2(1/2): 73-78. Illus. 1957.—A single comb White Leghorn hen was found to have oviducts on both the right and left sides but an ovary only on the left. The right oviduct was 66 cm long and weighed 44.0 g. It was larger than the left. The hen laid eggs (150 in 187 days) until the day before death. Two eggs were not laid in 1 day. No essential difference in histological features was observed between the 2 oviducts. The right was presumably normal and functional. Whether or not the right oviduct took in the ovulated yolk and completed egg formation could not be determined. The authors suggest that a breakdown in hormone equilibrium may cause the abnormal development of the right oviduct. (Biological Abstracts)

SIBBALD, I. R., and **LILIAN M. HUTCHESON.** (Ontario Agric. Coll., Guelph, Canada.)
THE CONVERSION OF β-CAROTENE TO VITAMIN A IN THE LIGATURED DUODENUM OF THE CHICK. Poultry Sci. 38(3): 701-706. 1959.—A mechanism capable of converting β-carotene to vitamin A is located in the duodenal wall of the living chick but does not appear to be present in the lumen of the duodenal loop. The activity of the converting mechanism is not changed when the duodenum is severed from the rest of the alimentary canal. When the blood supply to the duodenum is ligated no conversion of carotene to vitamin A takes place although some carotene is degraded. It would therefore appear that some factor(s) present in the blood is essential to the operation of the converting mechanism. (Biological Abstracts)

SIBBALD, I. R., and **LILIAN M. HUTCHESON.** (Ontario Agric. Coll., Guelph, Canada.)
THE INABILITY OF THE CROP TO CONVERT β-CAROTENE TO VITAMIN A WITHIN FOUR HOURS. Poultry Sci. 38(3): 698-

700. 1959.—A one inch, in line incision in the right-ventral side of the neck of the chick allows the exposure of the crop which may then be isolated by means of a ligature without interfering with the continuity of the alimentary canal. β-Carotene placed in such a ligated crop does not yield vitamin A within 4 hours even when bile (20%), pancreatin (4 g/100 ml) or bile + pancreatin is combined with the carotene solution. The crop wall seemed to be capable of absorbing carotene in the presence of bile. (Biological Abstracts)

SZENTMIHALYI, S.
DATA ON THE HAEMATOLOGY OF SPECIES-HYBRID DOMESTIC ANIMALS. (Adatok a fajhibrid haziallatok hematologiajahoz.) Allattenyesztes, Budapest, 1958. 2 pp. 155-162.—The author made comparative haematologic analyses from the blood of species-hybrid ducks originating from the crossbreeding of muscovy duck (Cairina moschata) and Hungarian white duck, from the blood of their parent species, as well as from the blood of mules, horses and donkeys. In comparison with the parent species significantly shorter blood coagulation time, higher fibrinogen level, shorter prothrombin and thrombin time, more rapid thrombin inactivation time, and lower free heparin level were found in the case of both species-hybrid animals. In addition to this, a higher thrombocyte number, slower denaturalisation of the haemoglobin, higher serum protein values, higher serum albumin-globulin quotient, and within the globulin fractions a higher gamma-globulin value were found in the species-hybrid ducks than in the parent species. According to the author a correlation exists between the short blood coagulation and the rapid wound-healing of the mule, furthermore between the higher gamma-globulin value found in hybrid ducks and the greater disease resistance of the hybrids. (Hungarian Agricultural Review)

TYLER, C. (U. Reading, Eng.)
THE INFLUENCE OF THE ZERO HOUR AND LENGTH OF THE TIME UNIT ON THE VARIATION OF DRY-MATTER EXCRETION IN BALANCE EXPERIMENTS WITH POULTRY. Jour. Agric. Sci. 51(2): 243-247. 1958.—The frequency of excretion of droppings by hens, counted at 15 minute intervals during the day showed a definite rhythm, but much of this variation was due to the disturbance to which the birds were subjected. The best zero hour appeared to be 14.0 hours, but considering the heavy excretions around 6.0 hours when the birds were 1st disturbed by attendants, 0.7 hours might be the ideal time. Previous experiments also supported this. There was a decrease in variation up to a unit of time equal to 3 days and times not multiples of days gave greater variations. (Biological Abstracts)

WEISS, HAROLD S. (Rutgers U., New Brunswick, New Jersey.)
THE INTERRELATIONSHIP OF REPRODUCTIVE STATE AND SEASONAL ACCLIMATIZATION ON THE HEN'S RESISTANCE TO LETHAL HIGH TEMPERATURE. Poultry Sci. 38(2): 430-435. 1959.—Hyperthermia was induced in individual, restrained White Leghorns by means of an incubator set for 105± 1/2° F. Body temperature, respiration rate, heart rate and blood pressure were monitored continuously for 4 hours or until death, whichever came first. Acclimatization was to seasonal temperature conditions; average maximum of 79°-88° F for the summer group and 38° F for the winter group. Layers and non-layers were differentiated as having laid at least 2 or no eggs respectively, in the week preceding the test. Non-layers survived 89 minutes longer than layers in the summer and 22 minutes longer in the winter. Non-layers weighed less than layers, but decreased feed intake is suggested as more important in determining tolerance. Seasonally, summer acclimatized birds survived longer than winter acclimatized birds (layers--34 minutes, non-layers--101 minutes). Prior to heat stress, neither body temperature, heart rate, or respiration rate differed among any groups, but blood pressure was higher in winter birds. At the point of maximal polypnea during heat stress, non-layers

attained a significantly higher respiration rate than layers, whereas by season only the time to reach peak polypnea was significantly prolonged in summer birds. The seasonal difference in blood pressure was also maintained during the heat stress. (Biological Abstracts)

WESSELS, J. P. H., and A. M. GERICKE. (Agric. Res. Inst., Pretoria, Africa.)

A COMPARATIVE STUDY OF GROWTH IN YOUNG FOWLS OF A LIGHT AND A HEAVY BREED. Union S. Africa Dept. Agric. Sci. Bull. 384. 1-34. 1958.—In growth experiment in 1950, 93 single Comb White Leghorn and 94 Black Australorp chicks were wing-banded and weighed weekly and feed consumption determined. Beginning at 4 weeks of age, 5 chicks were taken at random from each breed at weekly intervals and slaughtered and weighed. Rapid growth occurs from the age of 4 to 5 weeks onwards. Because of decline in efficiency of feed utilization Leghorn chickens should be sold before 16 weeks and Australorps before 18 weeks of age. Dressing percentage increased with age and increased more in Australorp than in Leghorn chickens. (Biological Abstracts)

WILLIAMS, DAVID DEWAYNE. (U. Illinois, Urbana.)

A HISTOLOGICAL STUDY OF THE EFFECTS OF SUBNORMAL TEMPERATURE ON THE TESTIS OF THE FOWL. Anat. Rec. 130(2): 225-242. Illus. 1958.—A study of temperature and temperature effects on the testis was made with 150 single comb white leghorn cockerels. Temperatures were taken with thermocouples attached to a potentiometer. The temperature was approximately 41.3° C in two different areas of the peritoneal cavity. A subcutaneous temperature gradient of 39.3 to 29.6° C exists from the axillary to the plantar regions. The development of the testis surgically displaced into a lateral subcutaneous position was more advanced than that of the testis in the normal position, perhaps due to the lower temperature (2.29° C lower) there. The testis displaced to the mesentery developed at the same rate as the control testis. However, pieces of testis transplanted subcutaneously to the axillary and pelvic regions exhibited slower development than the control testis. This delay was probably the result of inadequate vascularization in the transplant in comparison with the testis in its normal position since the temperatures were nearly the same as those of the side. Extensive atrophy resulted in pieces of testis transplanted subcutaneously into the superior tarsal and plantar regions. This may have been due to a combination of insufficient vascularization, pressure and low temperature. (Biological Abstracts)

NUTRITION

ACKER, ROBERT F. (Ames Assay Labs., Iowa.), **PAUL A. HARTMAN, JOHN R. PEMBERTON,** and **LOYD Y. QUINN.**

THE NUTRITIONAL POTENTIAL OF POULTRY OFFAL. Poultry Sci. 38(3): 706-711. 1959.—An extensive chemical and microbiological survey of both washed and unwashed poultry offal was made. Determinations on both types of offal included routine analyses, as well as assays for nutritionally significant enzymes, amino acids, vitamins, and minerals. Data presented indicated that the washed offal, particularly, had considerable promise as an animal feed or feed supplement. Practical and esthetic aspects of the nutritional potential of poultry offal are discussed and some possibilities for future studies suggested. (Biological Abstracts)

ADKINS, J. S., E. C. MILLER, H. R. BIRD, C. A. ELVEHJEM, and **M. L. SUNDE.** (U. Wisconsin, Madison.)

THE EFFECT OF A HIGH LEVEL OF DIETARY AMINO ACID NITROGEN ON EGG PRODUCTION AND BODY WEIGHT MAINTENANCE. Poultry Sci. 38(3): 638-646. 1959.—Studies involving eighty Single Comb White Leghorn pullets were conducted in an attempt to formulate an amino acid diet for laying hens. The diets

contained corn starch or dextrin, corn oil or soybean oil, minerals, vitamins, sodium bicarbonate, crystalline amino acids, and an anti-acid mixture. Egg production was not maintained with the essential amino acids (AA) (2% N) but was maintained if 4% crude casein or 5% gelatin was added. Four pullets receiving the essential AA's plus non-essential AA's averaged 52% production for 5 weeks, but they lost on the average 200 grams. The highest production obtained subsequently using the same type diet was 37.5%. Pullets fed 2% crude casein or blood fibrin plus amino acids equal to the basal diet maintained body weight and averaged 47.6 and 40.5% production respectively for 6 weeks, as compared to 8.3 and 17.9% for the AA basal diet. Pullets fed 17% casein diets averaged 69%. Lactalbumin, zein and Drackett protein at the 2% level also improved body weight maintenance and egg production slightly over the AA basal. The use of the amino acid diets depressed egg weight. Poor performance on some diets could be attributed to low feed intake. Excellent hatchability resulted in all experiments. (Biological Abstracts)

BEILHARZ, R. G., and **M. W. McDONALD.** (Poultry Expt. Sta., Seven Hills N.S. Wales.)

THE USE OF HIGH QUALITY FAT AND THE EFFECT OF PROTEIN LEVEL IN BROILER DIETS. Poultry Sci. 38(3): 519-526. 1959.—Experiments were carried out to determine the value of tallow and the effect of protein level in all mash broiler diets based on wheat-meal. Added fat did not affect growth rate but it improved feed conversion when measured as lbs. of feed consumed/lb. gain. Stabilization of the fat had no effect on body weight or feed efficiency. Birds fed protein levels of 25% to 8 weeks and 19% from 8 to 12 weeks showed considerably better growth rate than birds fed protein levels of 20% and 15% respectively. The weight increase shown at 8 weeks was not diminished at 12 weeks even where birds were fed at the lower protein level between 8 and 12 weeks. That differences in carcass composition were produced between treatments was suggested by independent variation of shank length and body weight. (Biological Abstracts)

BURGER, RAY E. (U. Minnesota, St. Paul), **N. S. Van MATRE,** and **F. W. LORENZ.**

GROWTH AND MORTALITY OF CHICKS AND PULLETS FED TRANQUILIZING DRUGS. Poultry Sci. 38(3): 508-512. 1959.—Chlorpromazine fed to Single Comb White Leghorn chicks at levels of 10-100 mg/kg of diet caused a slight but significant increase in growth, usually with decreased variability, by the 24th day of age. When fed at 250-16000 mg/kg growth was depressed and mortality was 100% by the 24th day of age in chicks fed the highest level. Reserpine similarly stimulated growth when fed at 0.5 mg/kg of diet and depressed growth at 5.0 mg/kg; 500 mg/kg caused 96% mortality. Reserpine mother liquor fed at 1.0 mg/kg diet stimulated growth of Broad Breasted Bronze poults. Reserpine produced overt tranquilization when fed at 5.0 mg/kg of diet or above, but chlorpromazine did not at any level fed. (Biological Abstracts)

CORDERO DEL CAMPILLO, M., and **J. A. GRACIA GARCIA.** (Regional Sheep-breeding Sta., Leon, Spain.) Sobre la eficacia de la penicilina-procaina y la tetraciclina (clorhidrato) aisladas y asociadas en la suplementación de raciones para pollitos.

ON THE EFFICACY OF PROCAINE PENICILLIN AND TETRACYCLINE (HYDROCHLORIDE) ALONE AND COMBINED FOR SUPPLEMENTING CHICK FEEDS. Rev. Patronato Biol. Animal 3(1): 5-75. 1957.—Detailed results are presented on a series of experiments with antibiotic supplementation of the rations of 1703 White Leghorn and Black Castillian chicks. Day-old chicks received supplements of 1.5 g tetracycline, or 2.0 g procaine penicillin G, or both antibiotics in these same amounts until the end of the experiment. In all experimental groups, the chicks reached a weight of 1 kg 1 or 2 weeks earlier than controls, whose weight they exceeded by about 10%. At the

end of the experiment, chicks given tetracycline weighed an average of 11.8% more than controls, those given penicillin 11.1% more, and those given both antibiotics 23.5% more. This finding suggests that the 2 antibiotics have a synergistic action, although this is denied by some. The coefficient of food utilization was very high in the case of the penicillin-tetracycline mixture, quite high in penicillin supplementation, and low in tetracycline supplementation. Tetracycline gave marked protection against loss by death or defect. Pencillin had little preventive effect, and losses among chicks receiving the combination were actually higher. From an economic standpoint, results are best with penicillin or penicilin + tetracycline. The high cost of the latter makes its use as a supplement impractical. (Biological Abstracts)

DAY, ELBERT J., and **JAMES E. HILL.** (Mississippi State U., State College.)

NEW FISH MEAL TESTED IN BROILER RATIONS. Poultry Sci. 38(3): 556-559. 1959.—Fish meal made by grinding, cooking and steam dehydration of whole fish caught in the Gulf Coast area was tested along with menhaden and sardine meals in 2 large broiler trials. About 98% of the fish used to make the new fish meal was a species commonly called "croaker" fish *(Micropogon undulatus L)*. The new fish meal contained about 61% protein and was as effective as menhaden or sardine meal when each meal was used in broiler rations to supply equal amounts of protein. A dietary level of approximately 2.5% was as effective as higher levels (about 50%) with all 3 meals. (Biological Abstracts)

DAY, ELBERT J., and **JAMES E. HILL.** (Mississippi State U., State College.)

ZINC, POTASSIUM, AND CERTAIN OTHER MINERALS AS ADDITIVES TO PRACTICAL TYPE TURKEY STARTER AND GROWER RATIONS. Poultry Sci. 38(3): 646-649. 1959.—Supplementary zinc (50 ppm) improved growth, feed utilization and reduced the incidence of hock disorder in turkeys to 20 weeks of age; whereas the addition of molybdenum, iron, copper and cobalt to the ration exerted no apparent effect. Soft phosphate containing about 9% phosphorus added (24.56 and 49.12 lbs. per ton) to replace 25 and 50% of the phosphorus furnished by the defluorinated rock phosphate in turkey rations did not adversely affect the performance of the turkeys at either 8, 16 or 20 weeks of age. (Biological Abstracts)

DU PLESSIS, P. H. C., and **J. ERASMUS.** (Pretoria University, South Africa.)

THE PROTEIN REQUIREMENTS OF LAYING HENS. South African Journal of Agric. Sci. 2(1): 33-40. 1959.—Two groups consisting of 480 S. C. White Leghorn and 448 New Hampshire pullets were fed on rations containing 4 levels of protein. Protein levels of 13, 14, 15 and 16 per cent were fed in the first experiment and 14, 15, 16 and 17 per cent respectively in the second experiment. The data revealed that only the 13 per cent level had an adverse effect on egg production. Feed efficiency, mortality of hens and body weight was not affected significantly by the level of protein. The investigation indicated that 14 per cent of protein in the ration was required for egg production of hens kept semi-intensively. Each experimental ration was supplemented with protein in the ratio of approximately 4 parts of fish meal to 1 part of ground oil cake (peanut oil cake) by weight respectively.

EDWARDS, H. M. Jr., DONALD CHIN, LEO CHANDLER NORRIS, and **G. F. HEUSER.** (Cornell U., Ithaca, New York.)

DIFFERENTIATION OF UNIDENTIFIED CHICK GROWTH FACTORS IN LIVER. J. Nutrition 57(3): 329-344. 1955.—Studies have been completed on unidentified chick growth factors using a purified diet adequate, according to reported results, in all known nutrients. Doubling all of the vitamins in the basal diet, increasing the quantity of the essential minerals alone and in various combinations

and raising the quantity of essential amino acids by 10% failed to improve growth. The results of the investigation showed that chicks require for normal growth two factors in liver not identical with any nutrient previously reported to be needed, and also a third factor in fish solubles. Both liver factors were found in a 70% ethanol extract of the concentrated water-soluble material of liver. The results of counter-current distribution indicated that one of these factors is organic in nature and the other probably inorganic. (Biological Abstracts)

EDWARDS, HARDY MALCOLM Jr., ROBERT JOHN YOUNG, and **MARVIN BOB GILLIS.** (Internatl. Minerals and Chem. Corp., Skokie, Illinois.)

PHOSPHATE AVAILABILITY STUDIES WITH THE ASH OF UNIDENTIFIED GROWTH FACTOR SUPPLEMENTS. J. Nutrition 65(2): 305-316. 1958.—Experiments were conducted with turkey poults and chicks to determine if the ash of a mixture of unidentified growth factor supplements would affect the availability of inorganic phosphates. The relative biological values of various materials for turkey poults, assigning U. S. P. dicalcium phosphate a value of 100, were: c. p. dicalcium phosphate, 58; Curacao Island rock phosphate, 50; the unidentified growth factor ash, 64; and c. p. potassium phosphate (KH_2PO_4), 100. Supplementation with the ash of the unidentified growth factor supplements did not increase the availability of phosphorus from Curacao Island rock phosphate or c. p. dicalcium phosphate. In fact, the percentage bone ash in the tibia of turkeys fed combinations of these supplements were in line with those predicted from the relative availabilities of the individual phosphates. Similar results were obtained with chicks. The results showed that the presence of the unidentified growth factor ash did not influence the availability of phosphorus in a relatively unavailable phosphate such as Curacao Island rock phosphate. No growth response or increase in bone ash was obtained from zinc with chicks fed the blood fibrin diet. This diet contains enough zinc to more than satisfy the chick's requirement. (Biological Abstracts)

FISHER, HANS, ROBERT CHARLES SALANDER, and **MILTON WIGHT TAYLOR.** (Rutgers U., New Brunswick, New Jersey.)

THE INFLUENCE OF CREATINE BIOSYNTHESIS ON THE ARGININE REQUIREMENT OF THE CHICK. J. Nutrition 59(4): 491-499. 1956.—During the first 4 weeks of life, creatine biosynthesis is an important factor in the arginine metabolism of the chick. The arginine requirement during the first three weeks of life for growth and efficiency is greater than 1.3%, possibly as high as 1.9%. Before maximum values are reached, both growth and feed efficiency exhibit a unique plateau to increasing arginine supplementation. 4. The chick continues to divert arginine for creatine synthesis despite high muscle creatine levels produced by dietary creatine; consequently, there is little sparing of arginine by supplemental creatine. (Biological Abstracts)

FISHER, HANS, and **DEWEY JOHNSON, Jr.** (Rutgers U., New Brunswick, New Jersey.)

THE AMINO ACID REQUIREMENT OF THE LAYING HEN. I. THE DEVELOPMENT OF A FREE AMINO ACID DIET FOR MAINTENANCE OF EGG PRODUCTION. J. Nutrition 60(2): 261-273. 1956.—A free amino acid diet has been developed which will be readily consumed in adequate amounts by most hens with concomitant maintenance of normal egg production. Factors found to be of greatest importance in the formulation of this diet were the purity of the amino acid source and the caloric level of the diet consumed. In the latter respect, starch and 12% corn oil were used to maintain a high energy level with the amino acid mixture. Egg production provided an extremely sensitive criterion of amino acid requirement since on deficient diets production always ceased within one week. The usefulness of the free amino acid diet in studying amino acid requirements as well as other nutrients is emphasized. (Biological Abstracts)

FISHER, HANS, DEWEY JOHNSON, Jr., and GILBERT A. LEVEILLE. (Rutgers U., New Brunswick, New Jersey.)

THE PHENYLALANINE AND TRYOSINE REQUIREMENT OF THE GROWING CHICK WITH SPECIAL REFERENCE TO THE UTILIZATION OF THE D-ISOMER OF PHENYLALANINE. J. Nutrition 62(3): 349-355. 1957.—The utilization of D-phenylalanine as well as the requirements for L-phenylalanine and L-tyrosine by growing chicks were the subject of this report. It was found that D-phenylalanine is very poorly utilized as indicated by very slow growth obtained with the D-isomer alone as well as by a higher requirement for DL-phenylalanine than for the L form. The L-phenylalanine requirement of chicks is approximately 0.5% and the L-tyrosine requirement is not more than 0.5% It is suggested that these values be adopted in place of the old values of 0.9% and 0.7% based on former work. (Biological Abstracts)

GARDINER, E. E., H. E. PARKER, and C. W. CARRICK. (Purdue U., Lafayette, Indiana.)

SOFT PHOSPHATE IN CHICK RATIONS. Poultry Sci. 38(3): 721-727. 1959.—Experiments were conducted to determine whether soft phosphate with collodial clay could be used as a P supplement in chick rations. On an equal P basis, soft phosphate did not support as rapid growth as dicalcium phosphate. Data were collected to determine the factors responsible for the slow growth obtained with soft phosphate. Isocaloric rations containing as high as 6% of clay were fed to chickens without apparent adverse effects upon growth or feed conversion. The growth rate of young chicks fed diets containing 3.55% soft phosphate and 0.167% P from H_3PO_4 was comparable to that obtained with dicalcium phosphate. This suggests that the F or other toxic substances contributed to chick rations by 3.55% soft phosphate was not a factor in its inability to support rapid growth. A study of the fecal P of two-week old chickens indicated that the P in soft phosphate was not absorbed to the same extent as that from dicalcium phosphate. (Biological Abstracts)

GILBREATH, J. C., L. F. GARVIN, and Q. B. WELCH. (Oklahoma State U., Stillwater.)

EFFECT OF ORALLY ADMINISTERED RESERPINE ON EGG PRODUCTION AND QUALITY. Poultry Sci. 38(3): 535-538. 1959.—Results indicate that reserpine at the rate of 2.0 mg/kg of layer ration will support egg weight and shell thickness during periods of relatively high temperatures. The differences between treatment and controls were significant at the 5% level. There was no effect on albumen quality. Treatment birds consumed less feed than controls but layed fewer eggs. (Biological Abstracts)

GILLIS, MARVIN BOB, KENNETH WILLIAM KEANE, and RICHARD ANDREW COLLINS. (Internatl. Minerals and Chem. Corp., Skokie, Illinois.)

COMPARATIVE METABOLISM OF PHYTATE AND INORGANIC P^{32} BY CHICKS AND POULTS. J. Nutrition 62(1): 13-26. 1957.—Both normal and vitamin D-deficient chicks and poults received equivalent quantities of P^{32} from either sodium phosphate or calcium phytate. Measurements of radioactivity in blood, bone ash and excreta were made 48 hours after dosing with the two sources of isotope. Normal young chicks utilized P^{32}-labeled calcium phytate only about one-tenth as effectively as inorganic orthophosphate, $Na_2HP^{32}O_4$. Normal young turkey poults made only neglible (less than 2%) use of calcium phytate compared with a disodium phosphate. In the presence of a deficiency of vitamin D, neither chicks nor poults made significant use of phytate phosphorus. However, the chicks' utilization of the inorganic source of isotope was not impaired by vitamin D deficiency. In poults vitamin D deficiency had a slight, but apparently significant, adverse effect on utilization of inorganic phosphorus. In vitro studies indicated that radioactive inorganic phosphate may exchange with phosphate in the phytin molecule. (Biological Abstracts)

GOGUS, K. A., and P. GRIMINGER. (Rutgers U., New Brunswick, N. J.) ON THE USE OF ASCORBIC ACID AS A STABILIZING AGENT IN PURIFIED CHICK RATIONS. Poultry Sci. 38(3): 533-535. 1959.—Vitamin deficiencies are sometimes observed with purified rations containing required vitamin levels. Ascorbic acid is thought to reduce destruction of vitamins, especially of thiamine, in purified diets. In 2 experiments, ascorbic did not enhance growth, nor did its omission cause visible symptoms of vitamin deficiencies. Whether the vitamins were included in the diet in dry form or in solution did not influence the experimental results. (Biological Abstracts)

HIGGINS, EDWIN S., DAN A. RICHERT, and WILFRED WIEDEY WESTERFELD. (State U. New York, Syracuse.) MOLYBDENUM DEFICIENCY AND TUNGSTATE INHIBITION STUDIES. J. Nutrition 59(4): 539-559. 1956.—Chicks fed a synthetic diet containing 20 μg Mo/kg developed normallly, but the addition of Na_2WO_4 (W: Mo ratio of 1000 or 2000:1) produced an apparent molybdenum deficiency as shown by: (1) depressed growth rate, (2) 25% mortality, (3) depletion of all tissue xanthine dehydrogenase and molybdenum concentrations, (4) replacement of one-half of the uric acid normally excreted by chicks with xanthine and hypoxanthine, and (5) complete reversal of all these effects by supplying an additional 2 mg of molybdenum as Na_2MoO_4 per kilogram of diet. The deposition of xanthine oxidase and molybdenum in rat intestine and liver was markedly reduced by a dietary W: Mo ratio of 100:1. All tissues were depleted of molybdenum and xanthine oxidase when the dietary W:Mo ratio was 1000 or 2000:1, but such rats grew and oxidized xanthine normally. The tissue changes were reversed by additional dietary Na_2MoO_4. No molybdenum deficiency was produced in rats after several generations on a diet containing 20μg Mo/kg. A protein-free diet had little effect on the molybdenum content of rat colon, spleen, lung or skin, but removed one-fourth of the molybdenum normally present in stomach, intestine and kidney, one-half of the molybdenum in muscle and brain, and two-thirds of the molybdenum in liver. The molybdenum removed from the tissues by protein deficiency or tungstate feeding appeared in the urine; neither diet interfered with the absorption of molybdenum from rat intestine. (Biological Abstracts)

JOHNSON, DEWEY Jr., and HANS FISHER. (Rutgers U., New Brunswick, New Jersey.) THE AMINO ACID REQUIREMENT OF THE LAYING HEN. II. CLASSIFICATION OF THE ESSENTIAL AMINO ACIDS REQUIRED FOR EGG PRODUCTION. J. Nutrition 60(2): 275-282. 1956.—The classification of amino acids according to their essentiality for the laying hen has been studied by use of a free amino acid diet. Arginine, glutamic acid, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine were found to be essential for egg production. With the exception of glutamic acid, omission of any one of the above amino acids resulted in immediate disruption of feed consumption and a 10-day pause in production when such incomplete diets were force-fed for only 5 days. Although feed consumption was not affected by the omission of glutamic acid, normal egg production could not be maintained. Tyrosine could be replaced by phenylalanine only with difficulty. The hen does not require glycine for egg production. This is in contrast to the need of the growing chick for this amino acid. (Biological Abstracts)

KLAIN, GEORGE JIRI, DOUGLAS CALVERT HILL, JEAN ALINE GRAY, and HUGH DOUGLAS BRANION. (Ontario Agric. Coll., Guelph, Canada.) ACHROMATOSIS IN THE FEATHERS OF CHICKS FED LYSINE-DEFICIENT DIETS. J. Nutrition 61(3): 317-328. 1957.—Four breeds of chicks, Barred Plymouth Rock, Black Minorca, Black Australorp and a New Hampshire X Barred Plymouth Rock cross de-

veloped an achromatosis of the feathers when fed a lysine-deficient diet. Cockerels were more severely affected than pullets. The symptom was not prevented by supplementing the diet with folic acid, iodinated casein, copper or tyrosine. The amino acid composition of achromatous feathers and normally pigmented feathers was similar. However, the tyrosinase activity of feather quill homogenates, as measured by pigment production on incubation with tyrosine, was less in achromatosis than in normal feathers. (Biological Abstracts)

LAKSESVELA, B. (Herring Oil and Meal Indus. Res. Inst., Straumsgrend, Norway.)
PROTEIN VALUE AND AMINO-ACID BALANCE OF CONDENSED HERRING SOLUBLES AND SPONTANEOUSLY HEATED HERRING MEAL. CHICK EXPERIMENTS. Jour. Agric. Sci. 51(2): 164-176. Illus. 1958.—In chicks fed a practically N-free basal diet supplemented with 10% of protein from either herring meal or condensed herring solubles, the latter appeared to be of negligible value as a protein source. Certain mixtures of solubles and meal protein proved superior to meal alone. When free amino acids were added singly to the solubles, only tryptophan caused improvements in growth and viability. Simultaneous addition of the 10 essential amino acids produced about 80% as much growth as that on meal alone. A mixture of tryptophan, isoleucine, histidine and phenylalanine was nearly as effective as all 10 essential amino acids. Absence of some of the 10, or addition of free amino acids at low levels caused adverse effects on growth. The small gain in weight of the chicks on solubles alone was attributable to water rather than to true tissue. Heating of the meal to a dark brown color changed the ratio of available amino acids enough to make it fail to sustain life; the available lysine fell 40%, but lysine alone could not have been the most affected amino acid. Addition of lysine, methionine or valine impaired growth, while the addition of all the 10 essential amino acids considerably improved it. Omission of lysine alone seemed to be without effect, but ommission of others affected growth. Tests with 2 non-heated and 3 variously heated samples of the meal showed that heating produced much greater decrease in growth rate than would have been expected from the differences produced in available lysine. (Biological Abstracts)

LOPEZ HERRERA, C. Análisis del gosipol en la harina de algodón. Prejuicios de su presencia en la alimentación animal.
ANALYSIS OF GOSSYPOL IN COTTONSEED MEAL. ILL EFFECTS OF ITS PRESENCE IN ANIMAL DIETS. Rev. Patronato Biol. Animal 3(1): 89-93. 1957.—The chief contraindication to the use of cottonseed as a food for animals is not its deficiency in vitamin B_{12} or lysine (supplements can be given), but the presence in the oil of gossypol, a toxic phenolic substance. The eggs of poultry fed on cottonseed meal have a disagreeable taste and the yolks are olive green. If most of the gossypol is extracted, this disadvantage can be eliminated, and meal containing no more than 0.04% gossypol gives good results in poultry feeding. Analyses of cottonseed meal products currently marketed in Spain revealed a gossypol content in excess of this maximum acceptable level in almost every case. Such products should be supplemented with soluble iron salts, to prevent undue absorption of gossypol, particularly by poultry. The production of cottonseed meal should be regulated to enforce the extraction of gossypol and prevent the marketing of products not labelled "gossypol-free." (Biological Abstracts)

MACHLIN, L. J., and R. S. GORDON. (Monsanto Chem. Co., St. Louis.)
EQUIVALENCE OF METHIONINE HYDROXY ANALOG AND METHIONINE FOR CHICKENS FED LOW-PROTEIN DIETS. Poultry Sci. 38(3): 650-652. 1959.—Addition of methionine hydroxy analog (MHA) and DL-methionine to diets containing 12 or 14% isolated soybean protein resulted in equivalent growth responses in young chickens. Only inconsistent growth responses were observed when diammonium citrate or urea was added to the diets. (Biological Abstracts)

MACRAE, H. F., D. S. LAYNE, and **R. H. COMMON.** Macdonald Coll. McGill U., Montreal, Canada.)

FORMATION OF ESTRONE, ESTRIOL AND AN UNIDENTIFIED STEROID FROM ESTRADIOL IN THE LAYING HEN. Poultry Sci. 38(3): 684-687. Illus. 1959.—When radioactive estradiol was administered intravenously to a laying hen, radioactive estradiol, estrone and estriol could be detected after one hour in the gut plus excreta by chromatographic and radioautographic methods. The fowl is able, therefore, to convert estradiol into estrone and estradiol. The gut plus excreta also yielded a radioactive steroid other than estradiol, estrone or estriol. This material was less polar than estriol but more polar than estradiol in a methanol-petroleum ether chromatographic system, and gave a strongly positive reaction with dinitrophenylhydrazine. (Biological Abstracts)

MAMEESH, M. S., BERNARD SASS, and **B. CONNOR JOHNSON.** (U. Illinois, Urbana.)

THE ASSESSMENT OF THE ANTIBIOTIC GROWTH RESPONSE IN THE CHICK. Poultry Sci. 38(3): 512-515. 1959.—By the addition of raw hen feces to the diet, it was possible to obtain consistent growth response to oxytetracycline in the laboratory. Under these conditions, feed-grade procaine penicillin gave a growth response only once in 4 experiments. Trimethylalkyl ammonium sterate had about half the growth-stimulating activity in 3 out of 4 experiments. Various forms of sulfur, including free sulfhydryl, disulfide, ring-sulfur compounds and copper sulfate were tested and found to be inactive in promoting chick growth. (Biological Abstracts)

MEDWAY, WILLIAM, and **MORLEY R. KARE.** (U. Pennsylvania, Philadelphia.

WATER METABOLISM OF THE GROWING DOMESTIC FOWL WITH SPECIAL REFERENCE TO WATER BALANCE. Poultry Sci. 38(3): 631-637. 1959.—Observations were made on White Leghorn females at 1, 2, 3, 4, 6, 8, 16, and 32 weeks of age. The milliliters of water drunk per gram of feed consumed ranged from 2.1 to 2.6 for all ages studied with the exception of the 32-week-old laying hens; here the amount was 3.6 ml/g of feed. The total excrement per gram of feed consumed ranged from 1.5 to 20 g. The daily water intake as fluid plus that present in the feed was 27.5 ml/bird for the one-week-old chick and 495.9 ml/bird for the 32-week-old hen. The total daily water loss was about 20.0 g/bird for the one-week-old chick and 406.9 g/bird for the 32-week-old laying hen. The birds were in a positive water balance throughout the studies. This was believed to be related to growth. (Biological Abstracts)

MENGE, HENRY, ROBERT JONES LILLIE, and **CHARLES ALEXANDER DENTON.** (U. S. Dept. Agric., Beltsville, Maryland.)

A CHICK-GROWTH FACTOR IN EGG YOLK. J. Nutrition 63(4): 499-508. 1957.—Day-old New Hampshire X Silver Cornish male chicks were fed a corn-soy diet adequately fortified with the known required nutrients. The addition of fresh or dried yolk to this diet resulted in a substantial increase in rate of growth for the 4-week assay period. When the basal diet was supplemented with fish solubules or a fish solubles concentrate, the chicks responded to fish factor. Addition of yolk in the presence of an adequate quantity of the fish factor caused an even greater increase in growth rate indicating that yolk contains an unidentified chick growth factor (s) not identical with the fish factor. Preliminary fractionation procedures have shown that the active principle is fat soluble since it can be extracted from dried yolk by the common fat solvents. The yolk factor is not identical with oleic acid, linoleic acid, or lecithin. The non-phospholipid and the non-saponifiable portions of yolk extracts contain the growth factor. The yolk factor is destroyed by hot but not by cold saponification. Adjustments in the calorie:protein ratio of the diet and omission of alfalfa leaf meal (source of saponins)

from the ration did not affect growth response to yolk. (Biological Abstracts)

MILLER, V. L., G. E. BEARSE, YOSHIKIYO KIMURA, and **ELIZABETH CSONKA.** (State Coll. Washington, Puyallup.)

STRAIN DIFFERENCES IN MERCURY RETENTION BY CHICKS. Proc. Soc. Exptl. Biol. and Med. 100(2): 301-303. 1959.—Male chicks of 3 inbred lines at a weight of 175 to 600 were injected intramuscularly with 3 ml mercury as phenylmercury acetate/kg body weight. Daily analyses from the 3rd to 7th day indicated that one strain retained 2 to 3 times as much mercury at that analysis period as either of the other 2 strains. In a 2nd experiment using 2 of the strains under similar conditions a larger amount of mercury was retained by this strain, whether the mercury was injected as mercuric chloride, ethylmercury chloride, or the diuretic sodium 0 [(3 hydroxymercuric-2-methyoxypropyl)-carbamyl] phenoxyacetate (Salyrgan). The rentention difference was approximately the same for phenylmercury acetate and mercuric chloride but was less in the case of the other 2 compounds. (Biological Abstracts)

MORRISON, ALEXANDER BAILLIE, and **HERBERT PAUL SARETT.** (Mead Johnson and Co., Evansville, Indiana.)

STUDIES ON ZINC DEFICIENCY IN THE CHICK. J. Nutrition 65(2): 267-280. 1958.—During a 14-day experimental period (from 12 to 26 days of age) the growth of chicks fed a semi-purified diet containing soybean protein was significantly increased by addition of zinc to the diet. However, added zinc had no effect on the growth of chicks which received a similar diet containing casein and gelatin as the protein sources. Both diets contained approximately 30 p.p.pm. of zinc, 4.8 p.p.m. of which was supplied in the mineral mixture. Chicks which received the soybean diet with zinc omitted from the mineral mixture exhibited markedly retarded growth, lowered efficiency of feed utilization and shortened and thickened tibiotarsae. Zinc deficiency had no apparent effect on the percentage of ash in the tibiotarsae nor on liver or carcass composition. Omission of zinc from the mineral mixture in the casein-gelatin diet also depressed growth, although the growth depression was not as great as that observed with the soybean protein diet. Addition of excess calcium to the soybean protein diet depressed weight gain and feed efficiency. Additional zinc, however, counteracted these effects, suggesting that excess calcium may increase the dietary requirement of zinc. The possible relationship of the above findings to unidentified chick growth factors is discussed. (Biological Abstracts)

MORRISON, ALEXANDER BAILLIE, RICHARD DAM, LEO CHANDLER NORRIS, and **MILTON LEONARD SCOTT.** (Cornell U., Ithaca, N. Y.)

FURTHER EVIDENCE ON THE REQUIREMENT OF THE CHICK FOR UNIDENTIFIED MINERALS. J. Nutrition 60(2): 283-295. 1956.—In further work on unidentified chick growth factor, results were obtained which indicated that the basal diets supplied the chicks were adequate in amino acids, known vitamins and minerals, previously reported to be needed by animals. No evidence of an imbalance was obtained in the studies on required minerals. As a consequence it has been found, in confirmation of previous reports by this laboratory, that when a mixture of unidentified growth factor supplements is fed to chicks the growth response which is observed is due to the presence in the materials of both unidentified organic and inorganic constituents. The results of the investigation showed, therefore, that a mineral or minerals not hitherto considered to be essential in the nutrition of the chick is present in the mineral portion or ash of certain crude feedstuffs. The unidentified mineral(s) was found to be involved in bone formation. Evidence was also obtained which indicated that the unknown mineral nutrient(s) is present in the boiling water-insoluble fraction of the ash of the mixture of unidentified factor supplements,

and that it is cationic in acid solution. No consistent effect of the ash on the intestinal microflora of the chicks or the pH of the intestinal contents was observed. (Biological Abstracts)

NESHEIM, MALDEN CHARLES, and **MILTON LEONARD SCOTT.** (Cornell U., Ithaca, N. Y.)

STUDIES ON THE NUTRITIVE EFFECTS OF SELENIUM FOR CHICKS. J. Nutrition 65(4): 601-618. 1958.—Symptoms of exudative diathesis were prevented in chicks by the addition of selenium as sodium selenite to vitamin E-deficient diets containing either torula yeast or isolated soybean protein as the source of protein. Injected selenium also prevented exudative diathesis. Further studies indicated that addition of selenium to the torula yeast-containing basal diet caused an increase in growth even in the presence of high levels of vitamin E. The amount of selenium required to give maximum growth in the presence of vitamin E was about two-thirds the amount of selenium required to prevent exudative diathesis in the absence of vitamin E. Tentative total requirements were determined. Selenium was effective in increasing serum albumin levels in vitamin E-deficient chicks. Selenium apparently did not prevent encephalomalacia, but was at least partially effective in preventing muscular dystrophy in chicks fed a diet low in methionine and vitamin E. Among several feed ingredients studied, the petroleum ether-extracted residues of soybean oil meal and standard middlings were especially high in a factor, presumably selenium, that prevented exudative diathesis in chicks fed a torula yeast-containing diet. (Biological Abstracts)

O'DELL, B. L., P. M. NEWBERNE, and **J. E. SAVAGE.** (U. Missouri, Columbia.)

SIGNIFICANCE OF DIETARY ZINC FOR THE GROWING CHICKEN. J. Nutrition 65(4): 503-524. 1958.—Broiler strain chicks were maintained on a zinc-deficient diet (15 p.p.m.) for periods of 4 or 6 weeks. In part of the trials the chicks were kept in galvanized batteries and they developed mild symptoms of a zinc deficiency. In other trials the batteries were coated with lacquer and the chicks developed severe deficiency symptoms. The symptoms of a mild deficiency included slow growth, shortening and thickening of the long bones, development of frizzled feathers, an abnormal respiration and an unsteady gait. The more severely depleted chicks exhibited these same symptoms but to a greater degree and in addition, developed a keratosis of the skin and an increased packed red cell volume. Microscopically there was evidence of parakeratosis in the esophagus and of poor calcification of the bone. There also appeared to be a failure of cartilage cell development in the epiphyseal plate region of the long bones and decreased osteoblastic activity in the thin bony collar. The zinc requirement of chicks fed 1.6% of calcium, 0.7% of phosphorus and maintained in lacquered batteries was estimated to be 35 p.p.m. This requirement was decreased slightly by lowering the calcium to 1.1%, but did not appear to be increased by 2.1% of calcium. In the presence of adequate zinc the chicks grew equally well at all calcium levels. (Biological Abstracts)

OLSEN, ELLEN M., J. D. HARVEY, D. C. HILL, and **H. D. BRANION.** (Ontario Agric. Coll., Guelph, Canada.)

DISTRIBUTION OF CAROTENE AND VITAMIN A IN THE TISSUES OF CHICKS FOLLOWING ADMINISTRATION OF CAROTENE. Poultry Sci. 38(3): 688-693. 1959.—Beta-carotene, given orally to chicks as an aqueous suspension containing Tween 60, appeared in the intestinal tissue as vitamin A within 1/2 hour following administration of the dose, and in the liver in about 1 hour. The peak occurred in the intestinal tissue at approximately 4 hours and in the liver at approximately 8 hours. A very small deposition of carotene occurred in the liver but this disappeared within 24 hours. Beta-carotene administered by cardiac injection in the form of a suspension in chick plasma was

apparently not converted to vitamin A by the chick. About 1/3 of the injected carotene was found in various organs of birds killed during the 1st 2 hours following injection and this amount decreased to about 3% after 4 days. No carotene was found in circulating plasma 1 hour after injection, or at any subsequent sampling to 21 days. (Biological Abstracts)

PEREZ GARCIA, T., and J. RUBIO PAREDES. La vitamina A como factor de fertilidad en el gallo.

VITAMIN A AS A FERTILITY FACTOR IN THE ROOSTER. Rev. Patronato Biol. Animal 3(1): 77-87. 1957.—White Leghorn roosters 10 months old were fed a regimen low in vitamin A and carotene or the same diet supplemented with 10,000 IU vitamin A per kg feed (controls). Study of sperm quality in the 2 groups showed no appreciable effect of hypovitaminosis A on the volume of the ejaculate. However, macroscopic differences were noted: the sperm of the experimental roosters was more transparent and of watery consistency. Individual motility was depressed in hypovitaminosis A, showing a progressive decrease up to 15 days, when values were 1/5 of normal. At this same time, sperm counts gave extremely low values. In one case the weekly average was as little as 43,000 per cu ml. The number of abnormal forms increased. These indications of impaired fertility were not accompanied by decreased libido or by other changes in the condition of the roosters, with the exception of skin pigmentation. The changes could be reversed in 2 weeks by the administration of 30,000 IU vitamin A per kg feed. In roosters, spermatic changes seem to be the initial sign of vitamin A deficiency. (Biological Abstracts)

POLIN, D. (Merck Inst. Therap. Res., Rahway, New Jersey.)

PORPHYRIN FORMATION BY TISSUES FROM LAYING HENS FED NICARBAZIN. Proc. Soc. Exptl. Biol. and Med. 100(4): 695-698. 1959.—Feeding the coccidiostat nicarbazin to laying hens resulted in less protoporphyrin on their egg shells. A linear dose response was obtained between dietary levels of 0.002 to 0.010% nicarbazin. Tissue homogenates of follicular membranes, magnum, isthmus, uterus and small intestine from hens fed nicarbzain catalyzed as much porphyrin in vitro from δ-amino-levulenic acid as control tissues. Erythrocyte-porphyrin formation induced by repeated bleeding was not inhibited in medicated hens, laying shells with 75% less porphyrins than controls. The data suggest that decreased deposition of shell protoporphyrin caused by feeding nicarbazin does not result from inhibition of porphyrin synthesis. (Biological Abstracts)

SCOTT, M. L., F. W. HILL, E. H. PARSONS, Jr., J. H. BRUCKNER, and ELLSWORTH DOUGHERTY III. (Cornell U., Ithaca, N. Y.)

STUDIES ON DUCK NUTRITION. 7. EFFECT OF DIETARY ENERGY. PROTEIN RELATIONSHIPS UPON GROWTH, FEED UTILIZATION AND CARCASS COMPOSITION IN MARKET DUCKLINGS. Poultry Sci. 38(3): 497-507. 1959.—Results are presented which show that in White Pekin ducklings, by appropriate alterations in the energy:protein ratio of the diet, it is possible to produce marked changes in the carcass fat composition without appreciably changing growth or efficiency of feed utilization. No marked differences in growth were obtained by using diets of wide ranges in protein and/or energy content. Efficiency of feed utilization was improved as the energy content of the diet was increased, in the range of energy levels between 800 and 1250 Calories of metabolizable energy per pound of diet. When the ducks were reared under a moderate temperature environment, increasing the energy level of the diet above 1250 Calories of metabolizable energy per pound did not appear to cause any appreciable further improvement in efficiency of feed utilization. Duck carcass fat content increased in direct proportion to increases in the ratio of energy to protein in the diet, over the entire range of energy:protein ratios studied. Conversely, with diets of equivalent energy:protein ratios, carcass fat

content was approximately equal, even though the rations varied considerably in energy content. Very cold environmental conditions caused markedly decreased efficiency of feed utilization and carcass fat deposition, but did not greatly decrease growth. (Biological Abstracts)

THORNTON, P. A., and R. E. MORENG. (Colorado State U., Fort Collins.)
FURTHER EVIDENCE ON THE VALUE OF ASCORBIC ACID FOR MAINTENANCE OF SHELL QUALITY IN WARM ENVIRONMENTAL TEMPERATURE. Poultry Sci. 38(3): 594-599. 1959. — Single Comb White Leghorn hens were maintained 1st under a cool environment and then moved to an environmental chamber where the temperature was kept at 83.6 ± 0.4 F°. The control group was fed a normal egg-laying diet while the experimental group was given this diet supplemented with 10 mg of ascorbic acid per pound of ration. It was observed that the ascorbic acid supplemented group had a significantly thicker egg shell, consumed slightly more feed and had a higher oxygen intake under the cool environmental conditions. When the birds were moved to the warmer environment it was noted that the control group lost more weight than the experimental group. It was also observed that while both groups showed a decline in egg shell thickness, oxygen uptake and feed consumption, the decline was much greater in the control group than in the experimental. No diferences in the 2 groups were observed under either environment for egg production, egg size or interior egg quality. These results indicate that ascorbic acid is effective for partially preventing normal decline in feed consumption and egg shell thickness in the chicken. Since oxygen consumption was significantly greater in the experimental group it appeared that ascorbic acid may have had an influence on thyroid activity, of a stimulatory nature, particularly under the conditions of increased environmental temperatures. (Biological Abstracts)

TOTH, M.
THE INFLUENCE OF ANTIBIOTIC FEEDING ON EGG PRODUCTION. (Antibiotikum etetes hatasa a tojastermelesre.) Allattenyesztes, Budapest, 1958. 2. pp. 137-142.—An experiment was conducted by the author to ascertain the influence of egg production of Hungarian product oxytetracycline (terramycin containing the food-completing "Erra" preparation when mixed into the ration of hens (25 mg per kg of feedstuff). The results of the two month experimental period have shown that against 13,630 eggs of the control group (160 hens) the experimental animals (160 hens) produced 15,794 eggs i. e. 13.7 per cent more eggs were produced by the animals in the antibiotic-fed group than by the individuals of the control group. The author points to the fact that the application of the "Erra" preparation is undoubtedly economical and justified to increase production in large-scale poultry raising. (Hungarian Agricultural Review)

TYLER, C. (U. Reading, Eng.)
SOME WATER AND DRY-MATTER RELATIONSHIPS IN THE FOOD AND DROPPINGS OF LAYING HENS. Jour. Agric. Sci. 51(2): 237-242. 1958.—Food and water consumption and the exact time of secretion of one non-laying and 4 laying Rhode Island X Light Sussex hens were measured hourly from 6.0 to 22.0 hours. Each bird showed a typical pattern of behavior in relation to the time of the day when it ate food and drank water; for any bird variations of this pattern from day to day were small. Relationship between water intake and temperature, and water excretion via droppings and eggs was highly significant. Water intake, however, had a greater influence than had temperature on water output. In spite of errors caused by not knowing the amount of metabolic water produced, the excretion from lungs varied greatly from bird to bird on constant intakes of water and also in the same bird at different intakes. (Biological Abstracts)

URBANYI, L.
FEEDING EXPERIMENTS ON CHICKENS WITH FOOD RA-

TIONS CONTAINING SATISFACTORY PHOSPHORUS AND INCREASING QUANTITIES OF CALCIUM CARBONATE. (Csibeetetesi kiserletek elegendo foszfort es csoportonkent novekedo mennyisegu szensavas meszet tartalmazo eleseggel.) Magyar Allatorvosok Lapja, Budapest, 1958. 8-9. pp. 221-226.—Experiments lasting many weeks were carried out on six-day-old chickens of the Hungarian breed to establish the effect of the absolute and relative food content of phosphorus and calcium carbonate on development, the state of health and food converting capacity of these animals during winter weather poor in sunshine.

It could be observed that chickens supplied with food containing medium quantities (0.99 per cent) of calcium and suitable quantities (0.69 per cent) of phosphorus showed normal development without conspicuous disorders until the chicks were three weeks old. The development was different of chickens supplied with the same quantities of phosphorus but with increasing quantities of calcium (0.74—4.07 per cent. or 0—10 per cent $CaCO_3$) in different groups. The most advantageous effect was obtained by a food ration containing 0.7 per cent phosphorus whose soil-alkalinity was +25 mg acquiv, and the Ca/P ration of which was about 2. These results show that the organism of young chicks reacts as sensitively to deficient as well as to excessive doses of calcium.

Among groups fed different quantities of calcium carbonate, the most advantageous gain in body weight (0.08—0.30 kg/10 kg) and the best food converting capacity was observed in groups fed calcium and salt in medium quantities. The quality of dry food necessary for the production of one kg body weight was the lowest (3.60 kg) in this group and much higher (3.63—11.80 kg) in the others.

The experiments proved also that vitamin-D supply is indispensable for rearing chicks at winter time on premises lacking direct sunshine. Without such preparations more or less marked signs of rhachitis appeared. (Hungarian Agricultural Review)

WAIBEL, PAUL E. (U. Minnesota, St. Paul.)

METHIONINE AND LYSINE IN RATIONS FOR TURKEY POULTS UNDER VARIOUS DIETARY CONDITIONS. Poultry Sci. 38(3): 712-721. 1959.—With Broad Breasted Bronze and White turkey poults, neither increasing the protein level from 28% to 32% nor adding 10% dietary fat in practical type diets resulted in consistently faster growth. Combination of increased protein and energy resulted in increased growth. Using high energy diets containing 15% added fat, methionine was the limiting amino acid at 32% protein level, while both methionine and lysine were deficient at 28% protein. Supplementary methionine resulted in consistent growth responses with high-energy, isocaloric, 24 and 28% protein rations. Birds receiving the 28% protein series gained more rapidly than those on the 24% protein series. Weight differences at 6 weeks of age were still present at 15 weeks, although all birds received a common growing ration from 6-15 weeks. (Biological Abstracts)

WILLIAMS, MARY ANN, and **CHARLES RICHARD GRAU.** (U. California, Berkeley.)

ENERGY INTAKE AND BODY COMPOSITION OF THE CHICK IN RELATION TO THE DIETARY CONCENTRATIONS OF DIGESTIBLE CARBOHYDRATE AND DIGESTIBLE FOOD ENERGY. J. Nutrition 59(2): 255-265. 1956.—The utilization of metabolizable food energy for body energy gain was studied in chicks fed semipurified diets containing various levels of wood-pulp cellulose (cellu flour). A 15% sesame-seed protein diet, supplemented with 0.4% L-lysine, and the two modifications of this diet produced by the substitution of 5 and 15% cellu flour for glucose were fed ad libitum to 14-day-old chicks for a period of 21 days. The metabolizable energy concentration of the diets was determined from the heats of combustion of the diets and of the excreta collected during the three-week period. The metabolizable energy intakes from the basal and the 5% cellu flour diets were equal, but

the intake from the 15% cellu flour diet was somewhat less although all three diets allowed equal weight gains. The two former diets produced a significantly greater body fat content and a significantly lower body water content than did the 15% cellu flour diet. There were no significant differences in the final body weights or body protein contents produced by the three diets. (Biological Abstracts)

WILLINGHAM, HASKELL E., LEO S. JENSEN, and **JAMES McGINNIS.** (State Coll. Washington, Pullman.)

STUDIES ON THE ROLE OF ENZYME SUPPLEMENTS AND WATER TREATMENT FOR IMPROVING THE NUTRITIONAL VALUE OF BARLEY. Poultry Sci. 38(3): 539-544. 1959.—Experiments were conducted to determine the effect of different enzyme preparations on growth and feed efficiency of chicks and poults. Crude preparations from bacterial and fungal sources gave significant growth responses. A specially malted barley also gave a growth response. When a combination of fungal enzymes and the barley malt was used, a greater response was obtained than with either one alone, indicating that possibly different types of enzymes are involved. A crystalline bacterial amylase had no effect on growth of chicks, while a purified bacterial protease possessing essentially proteolytic activity and low amylase content gave a significant improvement in chick growth. Eight different varieties of barley grown in Washington were fed to chicks. Growth and feed efficiency were poor with all varieties. When the same barleys were supplemented with enzymes or water treated, a marked improvement resulted. The addition of fungal amylase to a diet containing barley caused a marked decrease in water consumption by chicks and a reduced moisture content of feces. When ground barley was wet with an equal amount of water, autoclaved 30 minutes at 10 p.s.i., dried, and fed to chicks, no improvement in growth was observed. When barley was treated similarly except for autoclaving, a highly significant improvement in growth and feed utilization was obtained. (Biological Abstracts)

YAMAMOTO, KOZABURO, and **TATSUO HOSODA.** (Fac. Agric., U. Tokyo.)

THE SENSITIVITY OF THE CHICKEN TO SYNTHETIC ESTROGEN AS DETERMINED BY VITELLIN PRODUCTIVE CAPACITY. [In Japanese with English summ.] Japanese Jour. Breeding 7(2): 119-124. 1957.—White Leghorn chickens, sib mating products, were injected intramuscularly with a solution of 50 mg of stilbestrol in 20 cc sesame oil in daily amounts of 0.425 mg on the 61st day after hatching and for 10 days thereafter. The sensitivity was determined by serum vitellin reaction. The author postulated that there were 2 strains of chicken, one sensitive, the other not. The sensitive group showed a positive reaction in 75%. The non-sensitive group showed a positive reaction in 29.41%. Significant positive correlation seemed to be present between the time required in vitellin production and age at first egg. The co-efficients of correlation were 0.527 in generation 1 and 0.619 in generation 2. No significant correlation was observed in intensity and clutch size. The author suggests, in spite of the small number of cases presented, that the difference in sensitivity may be under genetic control, and that it may have a relation to egg-productive characters. (Biological Abstracts)

PATHOLOGY

BUZA, L., G. HAJDU, and **Z. TEMESI.**

SOME CASES OF CONGRANULOMA OF HENS. (A tyukok coligranulomajarol nehany eset kapcsan.) Magyar Allatorvosok Lapja, Budapest, 1958. 8-9. pp. 247-250.—The authors have been on the alert of this disease, yet they observed no cases on 3428 hens and 90 other poultry carcasses or organs investigated during the years 1952 to 1955. Since then this condition has been diagnosed in 7 hens (0.1 per cent), but none in other poultry. Some carcasses with coli-granuloma came from poultry farms with defective housing and feeding conditions. Anam-

nestic data included long-lasting sickness, loss of weight and diarrhea and only seldom did sudden death occur. Pathological changes characteristic of coli-granuloma (yellow, tumor-like nodules with smooth or hardly tuberous surface) were found most frequently in the small intestines and in the caeca; in one case only were such tumors found in the gigerium, the liver or the ovarium. In six cases mucous strains of Coli-bacteria could be isolated. These strains could be classified into Aldasy's groups 0-33, 0-22 and 0-87. (Hungarian Agricultural Review)

BUZA, L.

MALFORMATIONS AND DEFECTIVE FORMATIONS OF CHICKEN EMBRYOS. (Adatok a csirkeembriok torzfejlodesehez es hibas fejlodesehez.) Magyar Allatorvosok Lapja, Budapest, 1958. 7. pp. 200-203.—In the hatching season of 1956, 4903 eggs were received for investigation from eight hatching stations. From 354 eggs (7.7 per cent) of them the agent of fowl typhoid was isolated. Early death of the chicken embryos may thus be caused to some degree by this infection. Beside this, genetic and external effects (unfavourable influences during hatching) caused most malformations observed in the cases investigated. The author tries to establish from the pathogenic changes observed the cause of early embryo death. In his opinion the biological control of hatching is necessary. In the order of frequency the author observed the following malformations and defective formations: 1. *Oedematous infiltration of the neck and occiput:* the bacteriologically sterile gelatinous infiltration of the subcutaneous connective tissue. 2. *Hose-like gigerium;* instead of a normal gizzard, it was like a thin-walled hose. 3. *Beak anomalies:* crossing of the lower and upper part of the beak, shortening of the upper beak, which often presented itself parallel with evolutionary malformations of the face and cranial bones or duplication of face-bones and brain anomalies. 4. *Eye defects:* partial or total absence of the eyes, supernumerary eyes, etc. Irregularities of the evolution of the eye were encountered more often on the left eye and the deviation to the left side of the upper part of the beak was also more frequently observed. 5. *Open cranial cavity.* 6. *Opened or defective closing of the thoracal and pelvical cavity.* 7. *Irregularities of members:* supernumerary toes, confluency of the toes, three legs, very short members, etc. 8. *Other malformations:* duplicated heart, S-like curvature of the spinal cord. 9. *Combined occurrence of the different malformations* observed in 70 cases. In 44 per cent of 1776 suffocated embryos and eggs defective formations or malformations were observed. In the opinion of the author it would be useful for specialists of veterinary diagnostic institutes systematically to investigate the causes of death and malformations of chicken embryos. (Hungarian Agricultural Review)

GRAUSGRUBER, W. Untersuchungen zum biologischen und serologischen Nachweis des Virus der Newcastle-Krankheit und der Klassischen Geflugelpest.

INVESTIGATIONS OF THE BIOLOGICAL SEROLOGICAL PROOF OF THE VIRUS CAUSING NEWCASTLE DISEASE AND CLASSICAL POULTRY PLAGUE. Wiener Tierarztl. Monatsschr. 45(2): 76-114. 1958.—Practically any material which is infected with Newcastle Disease (N C Kr) or with the virus of Classical Plague (K P) is suitable for direct proving for virus in animal experiments. The chickens used in the experiments have to be controlled serologically. Egg culture is a simple and sensitive method for the demonstration of the virus. The death of the embryo in itself is not sufficient proof of the inhibition of a virus. Its presence has to be demonstrated with the aid of hemagglutination inhibition reaction (H A H). The H A or the H A H reaction has gained the greatest eminence among serological research methods. The agglutination of sensitized erythrocytes of a chicken by antisera can also be used as a further serological method to prove the presence of N Kr or KP virus respectively. Which of the discussed

biological or serological methods is best suited to demonstrating the presence of N C or K P virus depends in each single case on the research material available. A large number of references are presented. (Biological Abstracts)

KARASSZON, D.

INVESTIGATIONS INTO THE PATHOLOGY OF HATCHING. (Kelteteskortani vizsgalatok.) Magyar Allatorvosok Lapja, Budapest, 1958. 7. pp. 197-200.—Systematic investigations were carried out for 18 months on 5000 chicken embryos which decayed or suffocated in the egg during hatching. Disadvantageous external circumstances interfere with the normal process of hatching and the regular development of embryos and cause in many cases malformations. Such circumstances are: changes in temperature, excessively high temperature, defective supply in humidity and air, obliteration of the pores of the shell, interruption of hatching, shaking of the eggs, toxic substances. irregular feeding and vitamin supply, hormones, X-ray and other irradiations, living pathogen agents, and several partly unknown external factors. First of all in the winter and early spring hatching period the following pathological changes occurred with the following frequency: *chondrodystrophia* (10-20 per cent), *dwarfishness* (5-15 per cent), *rickets* (15 per cent) acrania (20-25 per cent), *hernia cerebralis* (3-5 per cent), *anophthalmia*, *microphthalmia* and *synophthalmia* (in some cases), *campylognathia* (4-5 per cent), *psittacognathia* (0.5-1 per cent), *coelosomia* (8-10 per cent), *polydactylia* (1-2 per cent), *polymelia*, *nuditas*, *seminuditas* (in some cases), *position irregularities* (30-40 per cent), suffocation, tenacity (2-3 per cent), duo-, triple-, and *multiple twins* and *malformations* of these (in some cases). Only those malformations are described in detail in this paper which occurred more often in the material obtained from hatching stations. Fowl typhoid was diagnosed in 6 per cent of the cases. This infection begins to manifest itself on the sixth day of hatching; it reduces the viability of the embryos and causes death around the 15th day of hatching. In the opinion of the author in the present state of hatching technique an embryo loss of 20-25 per cent is generally acceptable. Conclusions are drawn on the causes of pathologic changes observed. (Hungarian Agricultural Review)

PALATKA, Z.

EXPERIMENTS FOR THE PROPHYLAXIS AND THERAPY OF FOWL TYPHOID BY BIOMYCIN IN DAY OLD CHICKS. Kiserletek a naposcsibek baromfityphusanak megelozesere es gyogyitasara biomycinnel.) Magyar Allatorvosok Lapja, Budapest, 1958. 8-9. pp. 226-229.—Biomycin (an analogue of aureomycin) is effective in vitro against the agent of fowl typhoid. This preparation exerts a preventive effect on the development of these bacteria in concentrations of 0.25-5 gamma/ml. But in cases of longer incubation the antibiotic substance decomposes and therefore its effect decreases considerably. Very high concentrations of the antibiotic substance are needed to exert a bactericidic effect.

In chicks fed continuously food containing biomycin, strains of B. pullorum resistant against this antibiotic may develop.

The therapeutical effect of biomycin depends on the date of the beginning and of the dose of the antibiotic given. Mortality is reduced by 69-80 per cent if given in a dose of 100,000 gamma/kg body weight at the time of infection or at the latest 24 hours thereafter. Doses of only 50,000 gamma/kg or given later than indicated above have no satisfactory effect.

As a prophylactic given in a daily dose of 1000 gamma for every chicken, it prevents the spreading of the infection and lowers the mortality and the number of carriers, but there is no sterilization of the organism from these germs. Chickens fed food containing biomycin showed a better development and food converting capacity. (Hungarian Agricultural Review)

MARKETING AND POULTRY PRODUCTS

ESSARY, E. O. (Virginia Polytech. Inst., Blacksburg.)
INFLUENCE OF MICROWAVE HEAT ON BONE DISCOLORATION. Poultry Sci. 38(3): 527-529. 1959.—Ten week old New Hampshire fryers weighing 3-3.25 lbs. eviscerated weight were divided into 6 lots of 2 birds each. One-half of each fryer in each lot was heated for either 2, 3, 4, 5, 6, or 7 minutes in an electronic oven to determine the effect of microwave heat on bone discoloration. The other halves of the same birds were used as untreated controls. After the halves were frozen and held for 3 months at -20° F they were defrosted at room temperature and the meat removed from the bones. The bones from control and treated halves were compared. The 2 minutes heating period resulted in a reduction of bone discoloration. The 4 minute heating period eliminated all bone discoloration. Longer heating times, while eliminating bone discoloration, caused the meat to show a partial cooked condition. The microwave heat coagulated the blood marrow which prevented the hemoglobin from passing through the bones during the process of freezing and thawing. Storage life and organoleptic values were not determined. (Biological Abstracts)

IWAMURA, IWAO, NORIO MURAI, and **TOSHIRO HIDAKA.** (Fac. Agric., U. Miyazaki, Japan.)
ON THE STRUCTURE OF EGGS. II. DISTRIBUTION OF FREE AMINO ACIDS IN FRESH HENS' EGGS AS DETERMINED BY PAPER CHROMATOGRAPHY. [In Japanese with English summ.] Bull. Fac. Agric. Univ. Miyazaki 2(1/2): 82-90. 1957.—The yolks, white, and germinal discs of fertilized eggs were studied. A total of 20 spots was revealed by the ninhydrin reaction on extracts from yolks. Fourteen were identified as cystine, aspartic acid, glutamic acid, serine, glycine, threonine, lysine, hydroxyproline, histidine, alanine, proline, tyrosine, valine, and leucine. Similar patterns were found for yolks and whites. On the basis of spot density and spot area, leucine, glutamic acid, alanine, and valine are found in the highest levels. Proline is the major component in the free amino acid fraction of egg whites. Sulfur-containing amino acids were identified as cystine and methionine sulfone. Trichloroacetic acid extracts of germinal discs from both fertilized and unfertilized hens' eggs were examined by ascending chromatography. Eleven amino acids (aspartic acid, cystine, serine, glutamic acid, glycine, alanine, lysine, hydroxyproline, histidine, valine, and arginine) predominated. (Biological Abstracts)

McKEE, ROBERT C., JULIAN CONKEY, and **JOHN A. CARLSON.** (Inst. Paper Chem., Appleton, Wisconsin.)
A STUDY OF THE COMPARATIVE SHELF LIFE OF WET AND DRY-PACKED POULTRY. Poultry Sci. 38(2): 260-271. Illus. 1959.—A study was carried out for the purpose of comparatively evaluating the shipping and storage of wet-pack eviscerated poultry as now processed and packed with the shipping and storage of dry-packed eviscerated poultry treated by using Acronize (chlortetracycline) and packed in corrugated containers. As indicated by the organoleptic evaluation and confirmed by the bacterial count data, the primary factors determining shelf-life of the poultry were ice (temperature) and the antibiotic. Within a general class of packaging (i.e., wet- or dry-pack) the weight loss during storage was approximately the same. Also, the weight loss with storage time appears to be quite uniform. (Biological Abstracts)

McVICKER, R. J., L. E. DAWSON, W. L. MALLMANN, SUE WALTERS, and **EVELYN JONES.** (Michigan State U., East Lansing.)
THE EFFECT OF CHLORTETRACYCLINE ON SHELF-LIFE OF FRESH POULTRY MEAT TREATED IN A COMMERCIAL PROCESSING PLANT. Poultry Sci. 38(2): 337-343. 1959.—Studies were undertaken to evaluate the effectiveness of chlortetracycline in extending shelf-life of fresh poultry meat as administered in a commercial processing plant. After processing, the birds were held either in ice or

refrigerated coolers during the holding periods. Bacterial counts, raw odor scores and flavor scores were recorded. Unpackaged, chlortetracycline-treated birds were not acceptable on the 10th day of storage, according to a raw odor panel. No apparent relationship existed between bacterial contamination and cooked flavor of breast and thigh chicken meat (without skin). Chlortetracycline was not effective in extending shelf-life of fresh poultry meat. No significant differences were noted between packaged and unpackaged treatments on shelf-life. Results of a sanitation survey in the plant showed that cholortetracycline was not a substitute for good plant sanitation. (Biological Abstracts)

MARQUESS, CARRIEMAE GARNES. (Iowa State Coll., Ames.)
FACTORS AFFECTING THE QUALITY OF ROASTED TURKEY. Dissertation Absts. 19(9): 2333-2334. 1959. (Biological Abstracts)

ORR, H. L., and E. S. SNYDER. (Ontario Agric. Coll., Guelph, Canada.)
A FURTHER STUDY ON THE USE OF PLASTIC FILM BAGS FOR EGG STORAGE. Poultry Sci. 38(3): 736-737. 1959.—Eggs stored at 30° F up to 6 months in plastic film bags maintained a consistently higher Haugh unit value than similarly stored oiled eggs. The percentage of eggs with interior quality below 66 Haugh units was slightly lower for the bag packaged. A slight mold growth was evident on some of the plastic bag-stored eggs at the end of the 4th month and also at 5 and 6 months with no apparent increase with time. After tempering any evidence of mold disappeared with no evidence of penetration through the shell. (Biological Abstracts)

STILES, P. G., and L. E. DAWSON. (Michigan State U., East Lansing.)
THE RELATIONSHIP OF OVIPOSITION TIME, CLUTCH POSITION, BAROMETRIC PRESSURE AND EGG WEIGHT TO THE INCIDENCE OF BLOOD SPOTS IN EGGS. Poultry Sci. 38(3): 586-589. 1959.—In comparing normal and blood spot eggs of a similar clutch position, it was found that the mean average oviposition time of eggs containing blood spots occurred approximately 30 to 50 minutes sooner than normal eggs. A higher incidence of blood spots was found in the 1st egg of a clutch than in eggs of succeeding clutch positions, which substantiates the findings of previous workers. No correlation was found between barometric pressure or net changes in pressure for the area and the incidence of blood spots in eggs laid 24 or 48 hours later. The mean average weight of eggs containing blood spots was significantly more than the mean average weight of normal eggs in similar clutch positions. The average weight of the blood spot eggs ranged from 0.77 to 1.93 g heavier than normal eggs. (Biological Abstracts)

WESLEY, R. L., and W. J. STADELMAN. (Purdue U., Lafayette, Indiana.)
MEASUREMENTS OF INTERIOR EGG QUALITY. Poultry Sci. 38(2): 474-481. Illus. 1959.—An experiment was conducted to measure broken out quality of eggs by the Haugh unit method, yolk index, chalazae size, yolk centering, yolk mottling, shape of thin albumen, shape of thick albumen, percent outer thin albumen, percent inner thin albumen, percent thick albumen, total percent thin albumen, thin albumen diameter, and thick albumen diameter. Conclusions drawn were that Haugh units, yolk index, thin albumen diameter, chalazae size and yolk mottling are the most practical interior quality measurements. Chalazae size and yolk mottling were not significantly correlated to any of the measurements used. A 2nd experiment was conducted in which eggs were evaluated for quality immediately after lay (within 1 hour) and 24 hours after lay. There was no appreciable change in chalazae size, yolk mottling or Haugh units during the 1st 24 hours after lay. Values for yolk index and thick albumen diameter decreased significantly during this same period. Statistically significant improvements in quality during the 1st 24 hours after lay were found with respect to thin albumen diameter, shape of thin albumen, shape of thick albumen, percent outer thin albumen, and percent total thin albumen. (Biological Abstracts)

MANAGEMENT

BAILEY, BERNIE B., JOHN H. QUISENBERRY, and JIMMY TAYLOR.
(Texas Agric. and Mechanical Coll., College Station.)

A COMPARISON OF THE SUBSEQUENT LAYING HOUSE PERFORMANCE OF RANGE AND CONFINEMENT REARED PULLETS FED ALL-MASH AND MASH AND OATS. Poultry Sci. 38(3): 559-564. 1959.—Results given are based upon 308 days of production begining when the birds were 156 days of age. Traits evaluated were (1) rate of production, (2) average egg weights, (3) feed efficiency, (4) body weights, (5) age at sexual maturity, (6) age at 50% production, and (7) mortality. Five commercial egg production stocks were compared. Two lots of approximately 90 birds each from the 5 stocks were used. During the growing period no artificial light was given and at 21 weeks birds were housed in individual laying cages. The use of oats in the rearing diet gave no differences of statistical significance. The only significant differences were between range and confinement reared birds. The confinement reared pullets reached sexual maturity and 50% production significantly ahead of range reared birds. After the 1st 28-day-period the range reared birds layed at a higher rate than those raised in confinement. Production for the 308-day-period was almost identical for both rearing treatments. Egg weight was significantly larger for the range reared birds. No significant differences in feed efficiency were noted for the 2 rearing treatment. The range reared pullets were significantly lighter in body weight at the beginning of the laying period but gained significantly more during the laying period. No significant differences in mortality were found between the rearing treatments. Birds on the range and in confinement were full-fed but those on the range ate less feed, probably due to the summer heat restriction. (Biological Abstracts)

BAILEY, BERNIE B., JOHN H. QUISENBERRY, and JIMMY TAYLOR.
(Texas Agric. and Mechanical Coll., College Station.)

A COMPARISON OF PERFORMANCE OF LAYERS IN CAGE AND FLOOR HOUSING. Poultry Sci. 38(3): 565-568. 1959.—Performance during the laying period in individual cages and in conventional floor units was compared for 4 commercial egg production stocks - 3 inbred hybrids and 1 strain cross White Leghorn. Performance factors compared were (1) rate of production, (2) egg weight, (3) body weight, (4) feed efficiency, and (5) mortality. At 147 days of age the pullets were randomly assorted into individual cages 10 inches x 18 inches and floor pens 12 feet x 24 feet, providing 3 square feet of floor space per bird. Production records were started at 156 days of age. Fourteen hours of light were provided for the 308-day-period. Both cage and floor birds received the same low fiber, 17% protein, layer diet. During the 1st seven 28-day-periods the caged birds exceeded the floor birds in production but for the last 4 periods the floor birds had the higher rate. Overall the caged birds exceeded the floor birds by 1.3% which approached significance at the .05 level of probability. The strains were not consistent in their relative performances in cages and on the floor. Caged birds layed significantly heavier eggs than the floor birds. At the beginning of the test the body weights of the caged and floor birds were the same but the caged birds gained significantly more and averaged heavier in body weight than the floor birds. The feed required to produce a pound of eggs was significantly less for the caged birds for all 4 stocks compared. This was true even though the difference in production was slight and the cage birds had a larger body weight to maintain. There was no significant difference overall in mortality attributable to the method of housing. The higher mortality of the strain cross White Leghorns housed in cages was largely due to cage fatigue. (Biological Abstracts)

BOGRE, J., and K. BARDOS.

THE PROBLEM OF EGG PRODUCTION INTENSITY IN HUNGARIAN POULTRY BREEDING. (A tojastermeles intenzitasanak

kerdese a magyar tyuktenyesztesben.) Allattenyesztes, Budapest, 1958. 3. pp. 273-280.—On the basis of biometrical analysis of the annual egg production data of 509 hens belonging to the yellow Hungarian breed of the State Farm at Felsobabad it was found that a positive correlation exists between annual production and the intensity of egg production ($r = +0.346$, $P = 0.1$). A positive correlation appeared also between the number of eggs produced up to 31st March ($r = +0.331$, $P = 0.1$), as well as the egg production in the spring months and intensity ($r = +0.531$, $P = 0.1$). A less pronounced, positive correlation was found between the number of brooding days and the annual average cycle-length ($r = +0.262$, $P = 0.1$), it is advisable, however, that this should be equally taken into consideration in the course of selection. According to authors' suggestion attention should be paid to improving the intensity of the egg production for the purpose of increasing the productivity of the Hungarian hens. (Hungarian Agricultural Review)

BOWMAN, J. C., and **J. D. H. ARCHIBALD.** (Thornber Bros., Ltd., Mytholmroyd, Halifax, Eng.)
EFFECT OF CONTROLLED LIGHTING ON PRODUCTION CHARACTERS IN THE FOWL. Nature 183(4668): 1138-1139. 1959. (Biological Abstracts)

HALE, R. W. (U. Belfast, N. Ireland.)
ABSENCE OF PEN EFFECTS IN LAYING EXPERIMENTS ON A SEMI-INTENSIVE PLANT. Poultry Sci. 38(3): 739. 1959.—In 5 flocks under standard management at the Agric. Res. Inst. of Northern Ireland, analysis of survivors' egg records to 500 days showed that variances between pens within hatches did not differ significantly from variances between pullets within pens in any year. (Biological Abstracts)

MERRITT, E. S., and **R. W. E. CLARRIDGE.** (Canada Dept. Agric., Ottawa, Canada.)
THE EFFECT OF LENGTH OF HOLDING ON THE HATCHABILITY OF GOOSE EGGS. Poultry Sci. 38(3): 660-663. 1959.—Three years' incubation data, involving over 12,000 eggs from the yearly breeding populations of a trapnested flock of Pilgrim geese, were analyzed to determine the effect of length of holding on hatchability. One year's data (1956) were on eggs held 1 to 7 days and 2 years' data (1957, 1958) on eggs held 1 to 14 days. There was no decline in the hatchability of eggs held up to 7 days (1956 data). However, analyses showed both a significant linear and quadratic trend in hatchability of eggs over the 14-day period (1957, 1958 data). The graphs indicated that there was little decline in hatchability of eggs held up to 10 days. Hatchability of eggs held 8 to 14 days was 5% lower than eggs held 1 to 7 days before setting. (Biological Abstracts)

MORGAN, WALTER C., and **BOYD J. BONZER.** (South Dakota State Coll., Brookings.)
STRESSES ASSOCIATED WITH MOVING CAGE LAYERS TO FLOOR PENS. Poultry Sci. 38(3): 603-606. 1959.—In 1957 and 1958 groups of hens which had been confined to cages until March 1 were intermingled, on the floor, with groups of hens which were constantly in floor pens. Prior to intermingling the cage hens laid at a higher rate than did those on the floor. There was a marked decrease in productivity for the cage-hens in March. A period of recovery resulted in approximately equal production rates for the groups by June, when the trials were terminated. Fertility and hatchability of eggs from the cage hens in March was very poor. April results were better. This suggests to the flockowner that 4 or 5 weeks should elapse for the readjustments required from moved cage hens before hatching eggs are saved. Observations concerning social readjustment difficulties are discussed. (Biological Abstracts)

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Australian Primary Producers Union, 10 Regent Street, Sydney, N.S.W.

Australian Turkey Federation, 76 Norfolk Road, Epping, N.S.W.

Egg and Egg Pulp Marketing Board, 528-530 Collins Street, Melbourne, C.I., Victoria

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Producers Co-Operative Ltd., Carlingford, N.S.W.

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Roche Products Pty. Ltd., 1 Barrack Street, Sydney, N.S.W.

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National Association of Poultry Packers Ltd., Briset House, Briset Street, London E.C.1
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American Poultry Journal, H. F. Eisert, Publisher, 180 N. Wabash Ave., Chicago 1, Ill.
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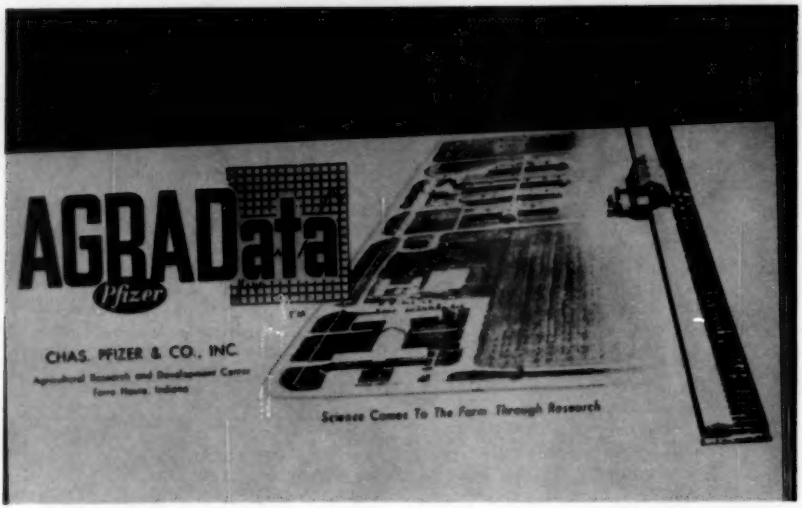

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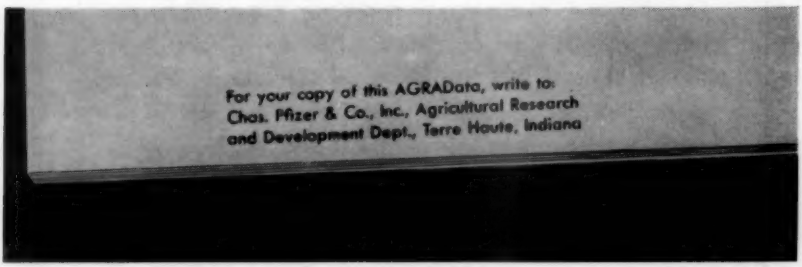
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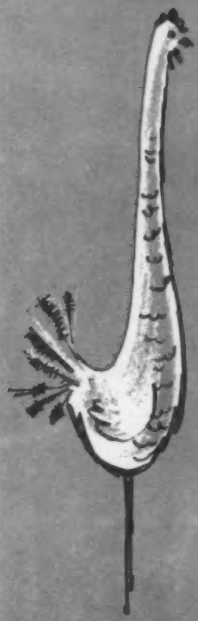

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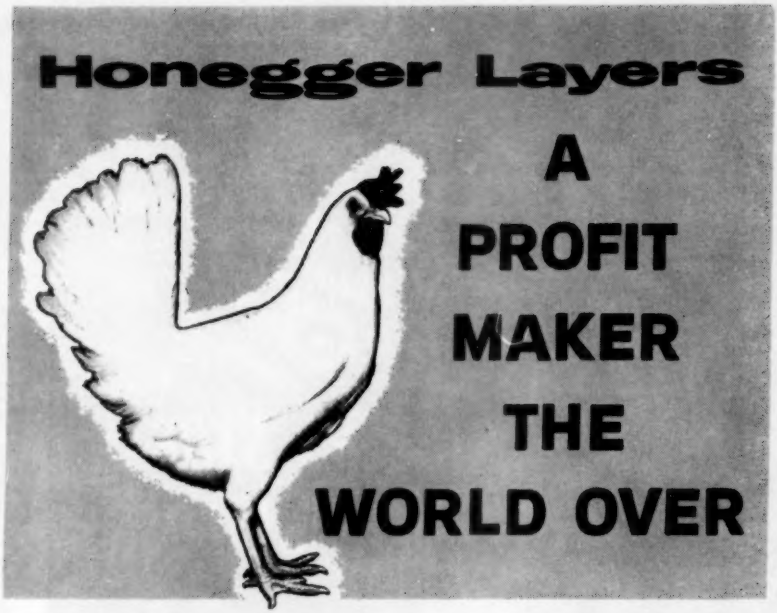

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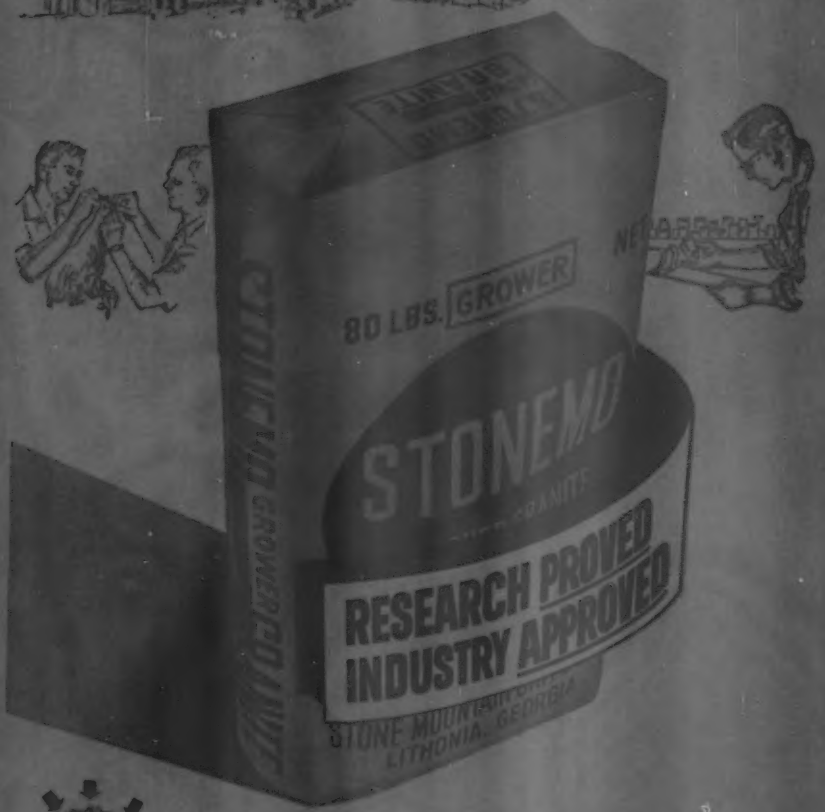

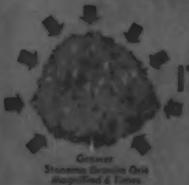

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